Firm Expectations and News: Micro v Macro*

Benjamin Born, Zeno Enders, Manuel Menkhoff,
Gernot J. Müller, and Knut Niemann

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Abstract

In this study, we investigate how firm expectations about their own developments respond to different types of news. We classify news as either micro or macro, with micro news being information about firm-specific developments and macro news being information about the aggregate economy. Our analysis of firm surveys from Germany and Italy shows that both types of news consistently predict forecast errors, contradicting the idea of full-information rational expectations. Yet while firm expectations overreact to micro news, they underreact to macro news. We propose a model in which firms suffer from "island illusion" to explain these patterns in the data.

Keywords: Firm expectations, survey, overreaction, underreaction, micro news, macro news, island illusion, business cycle

JEL-Codes: D84, C53, E71

*Born: Frankfurt School of Finance & Management, CEPR, CESifo, and ifo Institute, b.born@fs.de, Enders: Heidelberg University and CESifo, zeno.enders@uni-heidelberg.de, Menkhoff: ifo Institute and LMU Munich, menkhoff@ifo.de, Müller: University of Tübingen, CEPR, and CESifo, gernot.mueller@uni-tuebingen.de, Niemann: University of Tübingen, knut.niemann@uni-tuebingen.de. We thank Rüdiger Bachmann, Christian Conrad, Alexandre Kohlhas, and participants at various conferences and seminars for very useful comments. Financial support by the German Science Foundation (DFG) is gratefully acknowledged. The usual disclaimer applies.

1 Introduction

The question of how expectations about the economy adjust to news is key when it comes to understanding the expectation-formation process. The full information rational expectation (FIRE) hypothesis serves as a natural benchmark. Under FIRE, expectations adjust correctly and instantaneously in the face of new information and, as a result, forecast errors are not predictable on the basis of news. By now it is well established that actual expectations—as measured by survey data—fail to meet the FIRE benchmark. On average, expectations tend to underreact to news: Forecast revisions predict positive forecast errors consistent with the notion that it takes time to process information and in contrast to what the *full-information* assumptions imply (Coibion and Gorodnichenko 2012, 2015). Expectations of individual forecasters, however, tend to overreact to news—suggestive of a departure from *rationality*—and the literature is currently exploring explanations that can account for both observations jointly (Bordalo et al. 2020; Broer and Kohlhas 2022).

In this paper, we offer a new perspective. While existing studies focus on expectations of macroeconomic outcomes, maintained by professional forecasters, we turn to firm expectations about firm-specific developments. This has two advantages. First, we may classify news as either micro or macro, with micro news being information about firm-specific developments and macro news being information about the aggregate economy. Both are bound to matter for firm expectations. Second, by focusing on firm expectations (rather than on professional forecasters' expectations) we can exploit a much larger and richer data set and probe into the role of (firm) heterogeneity in the expectation-formation process. Specifically, we rely on the ifo survey of German firms which features responses from some 1,500 firms each month and covers 15 years of data. In addition, we verify that our main results also hold for the Banca D'Italia's "Survey on Inflation and Growth Expectations" (SIGE) of Italian firms.

We find that the distinction between micro and macro news is essential: firm expectations overreact to micro news, but simultaneously underreact to macro news. This feature emerges robustly across a variety of specifications and for all firm types that we consider (e.g., small and large, young and old). It also holds for different measures of expectations and different outcome variables. The variation of overreaction across firms is also systematically related to measures of firm performance. To rationalize these patterns in data, we put forward a stylized general equilibrium model. It builds on the noisy and dispersed information model of Lorenzoni (2009) but assumes, in addition, that firms suffer from "island illusion": They perceive what's happening to them as less common than it actually is. This departure from rational expectations allows the model to predict simultaneous over- and underreaction to micro and macro news.

More in detail, the first part of the paper presents new evidence on how firms' expectations change in response to news. To do this, we use data from the ifo survey of German firms, which is a well-known and widely used survey that has been conducted since 1949 and whose design has since then been adopted by surveys around the world (Becker and Wohlrabe 2008; Born et al. 2022). Our data covers the period from April 2004 to December 2019. For our baseline, we focus on firms' expectations about their production over the next three months, which are reported in a qualitative manner. This raises some challenges in defining forecast errors, which we address in Section 2 below. As an alternative, we also examine firms' expectations about their overall business situation, which is reported quantitatively and pertains to a six-month horizon.

To study how firm expectations respond to news, we adopt the framework developed by Coibion and Gorodnichenko (2015), which is by now widely used in the literature. The idea is straightforward: we regress firms' forecast errors about the change of production over the next three months on news that are available in the current month. News are the forecast revision, approximated by the current month's change in production expectations. Importantly, news may reflect firm-specific developments (micro news) or changes in the aggregate economy (macro news). We isolate the micro component by removing the time-fixed effect in the forecast revision that is common to all firms. We compile macro news, in turn, as the surprise component of the ifo index, measured as the difference between the current release of the index and the Bloomberg consensus forecast for the index, both available in real-time. Two aspects are important to note. First, the ifo index is constructed by aggregating expectations across firms in the survey such that micro and macro news are directly comparable but differ in the level of aggregation. Second, regarding the timing, we note that macro news are released at the end of the previous month and are thus available as firms report their forecast in the current month—just like micro news. For these reasons, both micro and macro news should not predict the forecast error under the FIRE hypothesis. And yet, our first key result, based on firm-level and pooled panel regressions, is that they do so robustly.

Our second result is that they do so in systematically different ways. Macro news, or information about the overall economy, tend to lead to positive forecast errors, meaning that actual production ends up exceeding expectations. More concretely, if the current ifo index surprises positively, firms' production is likely to exceed its expectations over the course of the next three months. In this sense, firm expectations do not fully account for macro news as they become available: they underreact to macro news. Micro news, instead, have a negative effect on the forecast error, that is, an upward revision of production expectations tends to be followed by a worse-than-expected output performance. Firm expectations respond too strongly to micro news: They overreact.

We find that these patterns are a robust feature of our data set. They emerge for alternative definitions of news and forecast errors and—more importantly—also once we consider firms' business expectations which are reported on a quantitative scale and pertain to a 6-month horizon. We also determine if our findings generalize beyond the ifo survey, which we are using as our main source of data. To do this, we turn to the SIGE. This survey provides us with a measure of firms' price expectations over a 12-month horizon, and we can use it to measure micro and macro news in a similar way to how we do with the ifo survey. And just like for the ifo survey, we find that firm expectations overreact to micro news but underreact to macro news.

In addition to analyzing the overall response to news using a panel of pooled observations, we also examine how individual firms respond to news by taking advantage of the large number of consecutive observations available for most firms in the ifo survey. We find that overreaction to micro news is a pervasive feature across firms. Firm-level estimates are consistently negative and tightly distributed in a narrow range. There is no significant difference in estimates across firm characteristics, such as firm size or firm age. The response to macro news is somewhat more dispersed across firms. Although there is underreaction for most firms, firms differ in how strongly they overreact to macro news. Larger firms, for instance, underreact more strongly. This result may reflect a stronger impact of the macro economy on the production—and hence the forecast errors—of larger firms.

The estimated response coefficients also vary over time, although they do not change their signs. The underreaction to macro bias is strongest during the Great Recession, reflecting a stronger impact of the macroeconomy in turbulent times. We also find that underreaction and overreaction are persistent over time—forecast errors respond not only to current but also to past news. Their impact dies out only gradually over a one-year period. Lastly, we establish that the variation in the reaction to news across firms correlates with firm-level outcomes in a systematic way. We find, in particular, that a stronger overreaction to micro news is associated with lower profits, and both, overreaction to micro news and underreaction to macro news is associated with higher firm-level volatility. These findings are consistent with earlier work which shows that firm expectations matter for firm outcomes (Bachmann et al. 2013; Enders et al. 2022).

In the last part of the paper, we put forward a general equilibrium model in order to rationalize our findings. The model builds on Lorenzoni (2009), which in turn is based on Lucas (1972). We modify the original model by assuming that firms are prone to "island illusion," meaning that they tend to underestimate the influence of overall economic conditions on their own performance. We think of island illusion as an instance of salience, which Taylor and Thompson (1982) define as "the phenomenon that when one's attention is differentially directed to one portion on the environment rather than to others, the information contained in that portion will receive disproportionate weighing in subsequent judgments" (see also Bordalo et al. 2013). Island illusion is also consistent with the notion that firm-specific developments are salient stimuli to firms because they attract firms' attention "bottom-up, automatically and involuntarily" (Bordalo et al. 2022). As such they feature disproportionately in firms' judgments—while other sources of information have to be gathered and proceeded actively.

Our model setup differs from earlier work by Bordalo et al. (2020) and Broer and Kohlhas (2022) as we model the response of expectations about firm-level outcomes in a fully specified general equilibrium setting. This is essential in the context of our analysis because it allows us to account for the cross-equation restrictions which govern the impact of micro and macro news on firm expectations. In the model, information is dispersed across firms. Firms observe their own developments plus a public signal and use this information to forecast sales. Prices are set before actual sales are observed and firms are assumed to adjust production in order to meet demand given posted prices. Consequently, the aggregate state of the economy is important for firms when it comes to forecasting their own production. The model is sufficiently stylized and so that we can derive our main result in closed form: We show that island illusion causes firm expectations to overreact to micro news and underreact to macro news. It also accounts for how differences in the response to news across firms correlate with firm outcomes.

The paper is organized as follows. In the remainder of the introduction, we place the paper in the context of the literature. Section 2 provides details about the ifo survey and our data set. In Section 3, we introduce our empirical framework and present the results and complement our empirical analysis with results for the SIGE survey. We develop and solve a general equilibrium model with dispersed information and island illusion in Section 4. The final section offers some conclusions.

Related Literature. At an empirical level our work differs from much of the literature which is concerned with macroeconomic expectations of firms, surveyed by Candia et al. (2022). So far, only a limited number of studies have analyzed firm expectations about firm outcomes, see Born et al. (2022) for a survey. Massenot and Pettinicchi (2018), in particular, use ifo data as well and regress expectations and forecast errors on past changes of the business situation (rather than on forecast revisions). They find the regression coefficient is positive and significant and robustly so across a number of specifications. They refer to this result as "over-extrapolation". Enders et al. (2019), in turn, take a macro perspective and document that the response of firm expectations to monetary policy shocks is non-linear in the size of the shock. Neither of these studies distinguishes between the response to micro and macro news as we do in what follows.

At a conceptual level, our paper relates to studies that propose departures from the FIRE benchmark. Some authors emphasize that a (rational) focus on certain sectors/media distorts the information formation process (Chahrour et al. 2021). In related work, Kohlhas and Walther (2021) put forward a model of asymmetric attention which rationalizes the observation that forecasts of output growth underreact to *average* forecast revisions (news) but overreact to recent realizations of output growth. They stress, however, that asymmetric attention arises naturally in a rational framework. Other recent models, instead, allow for behavioral aspects in the expectation formation process (for instance, Shiller 2017; Bordalo et al. 2019; Azeredo da Silveira and Woodford 2019). Under certain conditions, behavioral models and incomplete information models give rise to equivalent equilibrium effects (Angeletos and Huo 2021). Carroll et al. (2020) put forward a model of sticky expectations to account for evidence on consumption dynamics. A key assumption in their analysis is that information about macroeconomic quantities arrives only occasionally. Farmer et al. (2021) rationalize forecasting anomalies in a model with learning. Our model differs from these approaches in that it can simultaneously account for over- and underreaction to news in a general equilibrium setting. Such a setting is key because it allows us to model expectations about firm outcomes based on micro and macro news consistently.

2 Measuring forecast errors and news

In this section, we first introduce our data set which is centered around the ifo survey of German firms. We also provide details on the construction and descriptive statistics of firms' forecast errors and the news measures on which our analysis in Section 3 builds.

2.1 The ifo survey

The ifo survey is a mostly qualitative, monthly survey among German firms and representative of the German economy (Hiersemenzel et al. 2022).[1] It was launched in 1949 and the micro-data is available for research since 1980. Participation is voluntary and firms only receive non-monetary compensation in the form of sectoral and aggregate results of the survey. The individual filling a firm's questionnaire is a member of the senior management, 85 percent are CEOs or department heads (Sauer and Wohlrabe 2019). Response rates for the ifo survey are generally high: out of all firms initially contacted in mid-2021, around two-thirds returned at

[1] Quantitative questions were added in 2005, distributional questions in 2013, see Bachmann et al. (2020, 2021) for details. While the survey is technically at the product level, we follow the literature (e.g., Enders et al. 2022; Bachmann et al. 2013; Born et al. 2022) and treat each respondent as a separate firm.

least two surveys. For the comparable Survey of Business Uncertainty in the United States, the response rate is around one-third only (Altig et al. 2022). Response rates remain high also after initial contact, with an average monthly response rate of 82 percent; the sample attrition is moderate (Enders et al. 2022).

Our analysis—in order to measure firms' forecast errors and news—builds on three main components: (i) the ifo Business Climate *Survey* in the manufacturing sector (IBS-IND 2020, from now on ifo survey), (ii) the ifo Business Climate *Index* (ifo index), and (iii) the Bloomberg consensus forecasts for the ifo index. Our sample is restricted by limited data availability of the Bloomberg forecasts and runs from April 2004 to December 2019.

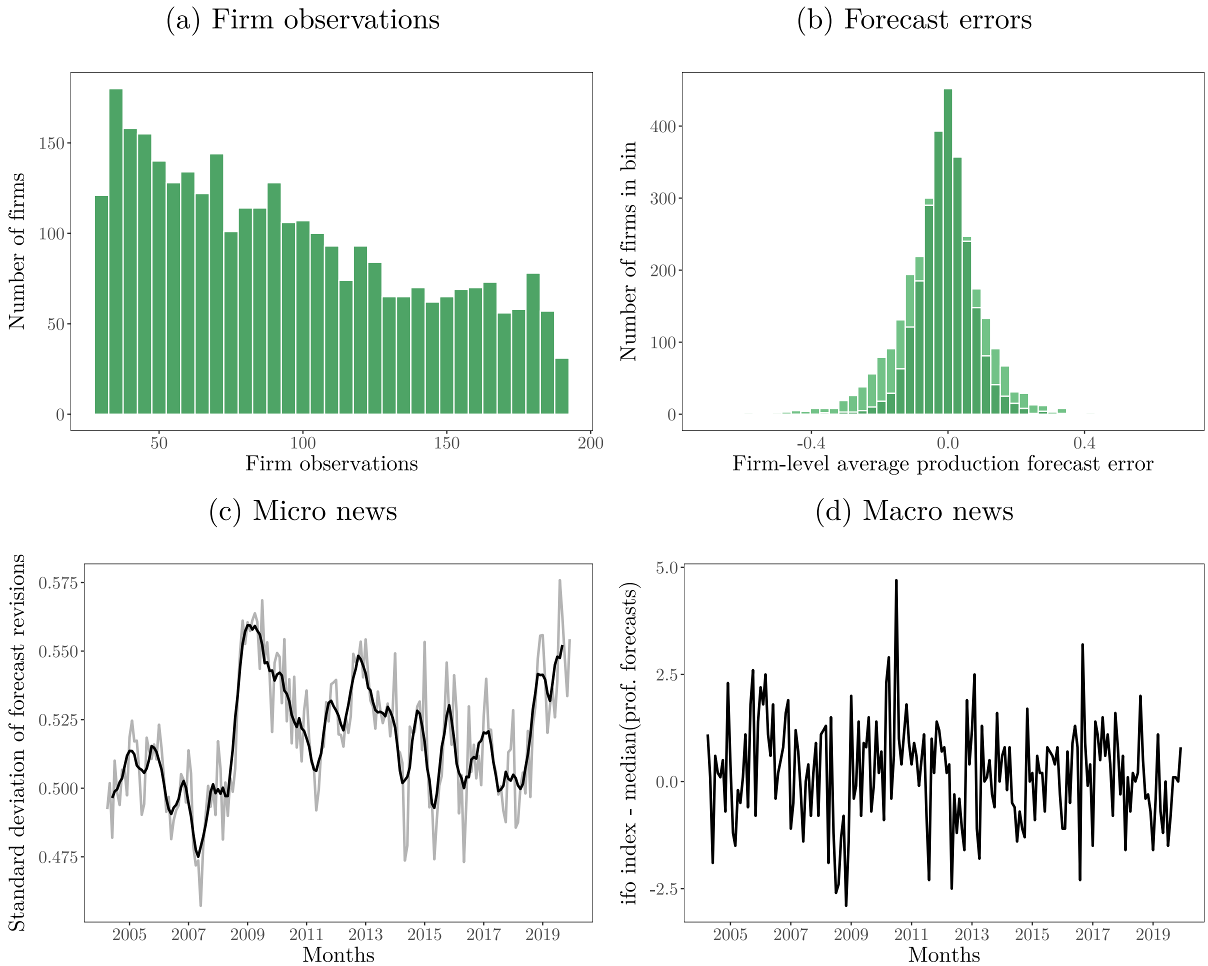
To measure firm expectations and forecast errors, we rely on the ifo survey. It features a core set of questions, including questions about the expected and actual production, prices, and business situation, where firms can report either an increase, no change, or a decrease. While this makes quantitative statements challenging, the qualitative nature arguably reduces the room for measurement error. In our empirical analysis, we rely on time-series data at the level of individual firms. Therefore, we restrict our sample to those firms which are in the survey for at least 30 months and which exhibit some time-series variation in their expectations and expectation errors. In any given month, this leaves us with more than 1,000 responses and often more than 1,500. Panel (a) of Figure 1 plots the distribution of firms sorted according to the number of months a firm is in the sample. The median firm is in the survey for around 90 months and 25 percent of firms are in the survey for more than 130 months. We exploit the fact that we have fairly long time series available for individual firms in our analysis in Section 3. In particular, it allows us to characterize the heterogeneity of the expectation-formation process systematically.

2.2 Forecast errors

To construct firms' forecast errors, we follow the approach of Bachmann et al. (2013) and focus on expected and realized production as reported in the ifo survey. Here, firms report for their own production the realized change over the previous month $x^i_{t,t-1} \in \{-1, 0, 1\}$ and the expected change over the following three months $F^i_t(x^i_{t+3,t}) \in \{-1, 0, 1\}$ (for the exact wording see Table A.1). To harmonize the time horizons, monthly realized changes are aggregated over the following three months: $x^i_{t+3,t} = \sum_{j=0}^{2} x^i_{t+j+1,t+j}$. Based on this aggregated realized change and the expected change, the forecast error is then defined as

$$x^i_{t+3,t} - F^i_t(x^i_{t+3,t}) = \begin{cases} 0 & \text{if } \operatorname{sign}(x^i_{t+3,t}) = \operatorname{sign}(F^i_t(x^i_{t+3,t})) \\ \frac{1}{3}(x^i_{t+3,t} - F^i_t(x^i_{t+3,t})) & \text{else.} \end{cases} \tag{1}$$

Figure 1: ifo survey, forecast errors, and news



Notes: Panel (a): distribution of monthly firm observations, i.e., the number of firms for which a firm-specific time series of a certain length is available. Panel (b): histogram of firm-level average forecast errors for production. The color indicates if estimates are significantly different from zero at the five percent level (light green) or not (dark green). Panel (c): cross-sectional standard deviation of micro news over time, defined as the forecast revision net of time-fixed effects, see Equation (3). The grey line depicts the standard deviation of micro news at a monthly level and the black line depicts the six-month rolling average. Panel (d): macro news shocks over time, defined as the surprise in the ifo index compared to median professional forecasts, see Equation (4).

When the signs of aggregated realized change and expected change coincide, no error is assigned. In all other cases, the forecast error is equal to the difference between aggregated realized and expected change, standardized by the forecasting horizon of three months.

Generally, we find forecast errors to be well-behaved. Panel (b) of Figure 1 shows the distribution of forecast errors: More than 75 percent of firm-level average forecast errors are not significantly different from zero. And while these forecast errors are based on qualitative rather than quantitative data, the key facts which characterize firms' forecast errors emerge robustly from qualitative and quantitative data and across countries, see Born et al. (2022) for a survey.

2.3 Micro news

Our measure of micro news is based on forecast revisions. Formally, we define the forecast revision of firm i in month t, $FR_{i,t}$, as the first difference of production expectations:

$$FR_{i,t} = \text{sign}(F_t^i(x_{t+3,t}^i) - F_{t-1}^i(x_{t+2,t-1}^i)) \ , \tag{2}$$

which is equal to 0 when there is no change in expectations, equal to +1 for an upward revision (for example, from no change in $t-1$ to an increase in t) and equal to -1 for a downward revision (for example, from no change in $t-1$ to decrease in t). As the forecast horizon is fixed at 3 months, the overlap in the monthly forecast revisions is two months. In what follows we thus assume that forecast revisions reflect mostly news (rather than changes in the forecast horizon).[2]

To show the informativeness of the forecast revisions, we plot average forecast revisions over time together with German manufacturing production growth in Figure A.1 in the appendix. In fact, the average forecast revision is a good leading indicator for manufacturing production. This is especially visible in the Great Recession of 2008/2009 as well as in 2018/2019 when the manufacturing sector cooled down significantly.

Importantly, firms are likely to revise expectations about their own production either because their expectations about the macroeconomy change or because they expect changes in their business conditions which are due to idiosyncratic developments. To isolate the latter component—that is to measure *micro news*—we remove time-fixed effects from the forecast revision, as defined in Equation (2):

$$FR_{i,t} = \mu_t + \text{micro news}_{i,t} \ . \tag{3}$$

In this way, we control for news which are common to all firms (while assuming that macro news load with the same factor for all firms). Panel (c) of Figure 1c shows how the cross-sectional dispersion of micro news fluctuates over time. It is largest during the Great Recession and towards the end of our sample period.

[2] In a robustness check below, we show that our results also hold for questions about firms' expected business situation. These questions cover the next six months, so the overlap in forecasting periods is five months, which underlines that our results are not driven by changes in the forecasting period.

2.4 Macro news

To measure macro news, we compute the *surprise component* of the ifo *index.* The ifo index is compiled on the basis of the ifo survey by the ifo institute and is a widely watched indicator of the German business cycle (Carstensen et al. 2020; Lehmann 2022). The index is based on firms' responses about their current business situation and their business expectations over the next 6 months (the exact wording is again in Table A.1).[3] The index is defined as follows:

$$\text{business climate}_t = \sqrt{(\text{business situation}_t + 200)(\text{business expectation}_t + 200)} - 200 \ ,$$

where business situation$_t$ and business expectation$_t$ are balances, that is, the share of positive answers ("increase") minus the share of negative answers ("decrease") across firms. For publication, the ifo institute reports the business climate as an index relative to a base year, which at the time of writing is 2015 (Sauer and Wohlrabe 2018).

We can measure the surprise component in the ifo index based on professional forecasts for the ifo index, available from the Bloomberg consensus survey. In this survey, professional forecasters can submit and update their forecasts of macroeconomic indicators, for example, GDP, employment, and confidence indexes, up until they are released. In the literature, these forecasts have been used to assess the impact of news on long-term treasury bonds (Altavilla et al. 2017) and stock prices (Elenev et al. 2022; Born et al. 2021; Gilbert et al. 2017; Kurov et al. 2019); see also the construction of uncertainty indexes by Scotti (2016) and the nowcast errors by Enders et al. (2021). For the German ifo index and starting in April 2004, the Bloomberg survey features roughly 40 professional forecasters.

We measure macro news as the difference between the published ifo index and the median professional forecast of the ifo index from Bloomberg. The timing is key: In the first three weeks of month $t-1$, firms respond to the survey. Until the last week of month $t-1$, professional forecasters submit their forecasts for the ifo index in $t-1$ to Bloomberg. In the last week of month $t-1$, the ifo institute then publishes the value of the ifo index. In the first three weeks of month t and after observing the macro news, firms again fill out the ifo survey. Formally, we have

$$\text{macro news}_t = \text{ifo index}_{t-1} - \text{median(professional forecasts for ifo index}_{t-1}) \ . \tag{4}$$

Figure 1, panel (d), depicts our macro-news measure as defined in Equation 4.

[3] Since April 2018 the ifo index also includes responses from firms in the service sector (Sauer and Wohlrabe 2018). In the appendix, we show that this does not affect our results.

Table 1: Macro news and forecast revisions

	$\widehat{\beta}$	$SE(\widehat{\beta})$
Macro News	0.008	0.001
Macro News		
× 1. Quartile by employees	0.007	0.002
× 2. Quartile by employees	0.008	0.002
× 3. Quartile by employees	0.008	0.002
× 4. Quartile by employees	0.008	0.001
Macro News		
× Firm age $<$ 20 years	0.007	0.003
× Firm age $<$ 20 years	0.006	0.001
Macro News		
× Time in survey $<$ half a year	0.015	0.007
× Time in survey $\geq$ half a year	0.008	0.001
Macro News		
× Lower macro importance	0.007	0.001
× High macro importance	0.006	0.003
Macro News		
× Positive sign of news	0.012	0.002
× Negative sign of news	0.005	0.001
Macro News		
× outside Great Recession	0.007	0.001
× during Great Recession	0.012	0.002

Notes: Reaction of forecast revisions to macro news. Firms' forecast revisions are regressed on macro news, interaction terms, and firm-fixed effects for each interaction variable separately. Standard errors are clustered at the firm level.

Macro news are part of the information set of firms when forecasting their production in t. First, media attention to the index as well as its professional forecasts is high due to its predictive power for the business cycle. The ifo index is ranked among Bloomberg's "12 Global Economic Indicators to Watch" and news outlets report on both the realized value and, importantly, the professional forecasts.[4] Second, firms receive the aggregate index (and sectoral results) as their compensation for participating in the survey. Third, regressing forecast revisions on macro news yields significant coefficients (see Table 1). More specifically, in order to investigate systematically how macro news impact firm expectations, we consider a number of specifications allowing for a number of interaction effects as we regress forecast revisions about firms' own production and business situation on macro news. Across specifications, the coefficients are highly significant and positive (although of limited

[4]Examples include leading weekly newspapers *Der Spiegel* and *Die Zeit*. Der Spiegel (Unternehmen sind wegen vierter Coronawelle äußerst besorgt, 24 November 2021) discusses the November 2021 index value of 96.5 as well as the professional forecast of 96.6. Die Zeit (Geschäftsklimaindex überraschend gestiegen, 25 January 2022) reports that, contrary to professional forecasts, the January 2022 index value increased by 0.9 points compared to the previous month.

economic impact). The positive sign shows that after receiving positive macro news in the form of a better-than-expected ifo index, firms revise expectations about their own production and business situation as well.

3 How firm expectations respond to news

In this section, we first introduce our empirical framework which builds on Coibion and Gorodnichenko (2015). We then report estimates for the average effect of micro and macro news across firms as well as results that account for firm heterogeneity. Lastly, we show how the reaction to news is related to real activity.

3.1 Empirical framework

According to the FIRE benchmark, forecast errors should not be predictable based on information that is available to the forecaster at the time of forecasting. This insight gives rise to a straightforward test. In influential work, Coibion and Gorodnichenko (2015) have put forward the following specification:

$$x_{t+h,t} - F_t(x_{t+h,t}) = \beta_0 + \beta_1 \cdot \text{news}_t + \varepsilon_t \ . \tag{5}$$

Here $x_{t+h,t} - F_t(x_{t+h,t})$ is a forecast error and news_t is some surprise, typically measured by forecast revisions. Under FIRE we have $\beta_1 = 0$. However, Specification (5) is not just informative about the FIRE benchmark. It also points towards specific alternative models of expectation formation. When positive news tends to be followed by positive forecast errors ($\beta_1 > 0$), the revised forecast is too small. Hence, there is an underreaction to news. Conversely, when positive news are on average followed by negative forecast errors ($\beta_1 < 0$), the forecast revision was too strong from an ex-post point of view: There is an overreaction to news.

Earlier work estimates versions of Specification (5) using data from the *Survey of Professional Forecasters* which typically pertains to macroeconomic outcomes. Specifically, Coibion and Gorodnichenko (2015), Broer and Kohlhas (2022), and Angeletos et al. (2021) consider the median (consensus) professional forecast for inflation and find positive regression coefficients. Bordalo et al. (2020), instead, focus on the individual forecasts and generally find negative coefficients pointing towards overreaction at the individual level.

As we build on Model (5) we make three innovations relative to earlier work. First, we consider firms, that is, actual decision-makers, rather than professional forecasters. Second, we focus on firm-level variables, notably production (and prices), rather than macro-level variables (such as aggregate inflation). Last but not least, we consider two sources of news, micro news, that is, the forecast revision net of time-fixed effects, and macro news, that is, the surprise component to the ifo index. This distinction takes center stage in our analysis and yields our baseline regression equation:

$$x^i_{t+h,t} - F^i_t(x^i_{t+h,t}) = \beta_0 + \beta_1 \cdot \text{micro news}^i_t + \beta_2 \cdot \text{macro news}_t + v^i_t \ . \tag{6}$$

Here, $x^i_{t+h,t} - F^i_t(x^i_{t+h,t})$ is a firm's forecast error for its own production defined in Equation (1) above, micro news is the production-forecast revision net of a time-fixed effect, as defined in Equation (3), and macro news is the surprise component in the ifo index of the previous month, as in Equation (4). In what follows, we refer to β_1 as "micro coefficient" and β_2 as "macro coefficient": under the FIRE benchmark, these coefficients are zero because micro and macro news are part of a firm's information set, as explained in the previous section.

3.2 Results

To establish our main result, we pool observations across time and firms to estimate Equation (6) while allowing for firm-fixed effects. The top panel of Table 2 displays the results for our baseline specification, which is based on firms' production expectations. The bottom panel shows results for firm expectations about their business situation which are measured on a quantitative scale. Consider the baseline in the top panel first. Column (1) on the left reports estimates for a specification that features micro and macro news simultaneously. Both types of news are not processed instantaneously and correctly as FIRE would have it: They induce predictable, statistically significant forecast errors. This feature of firm expectations is consistent with what earlier work has established for professional forecasts. In addition, we find that the type of is key for how expectations adjust: While positive micro news predict negative forecast errors, positive macro news predict positive forecast errors. This implies, as explained above, that firms overreact to micro news but underreact to macro news. This result is clear cut and turns out to be robust across a range of alternative specifications, as we document in the following. In Section 4 below, we offer a theoretical perspective based on a general equilibrium model where firms suffer from island illusion.

Before considering alternative specifications, we note that the magnitude of the coefficients in our baseline specification is quantitatively meaningful. In general, the economic importance of the news coefficients is not straightforward to assess due to the qualitative nature of the forecast revisions in our baseline specification. However, we may interpret their (relative) importance. The average absolute size of micro news is 0.296 and leads to an increase in the absolute value of the forecast error by 0.057 (that is, 0.16 standard deviations of the

Table 2: Over- and underreaction to news

(a) Firms' forecast errors about their production

	(1)	(2)	(3)	(4)
Micro News	-0.194***	-0.194***		
	(0.001)	(0.001)		
Macro News	0.021***		0.021***	0.022***
	(0.0007)		(0.0007)	(0.0007)
Forecast Revision				-0.191***
				(0.001)
Observations	302,737	302,737	302,737	302,737
R^2	0.16471	0.16015	0.08967	0.16260
Within R^2	0.08701	0.08202	0.00498	0.08471

(b) Firms' forecast errors about their business situation

	(1)	(2)	(3)	(4)
Micro News	-0.450***	-0.450***		
	(0.003)	(0.003)		
Macro News	0.687***		0.683***	0.843***
	(0.043)		(0.042)	(0.043)
Forecast Revision				-0.442***
				(0.003)
Observations	161,578	161,578	164,675	161,578
R^2	0.32430	0.32210	0.25535	0.32261
Within R^2	0.09227	0.08931	0.00290	0.09000

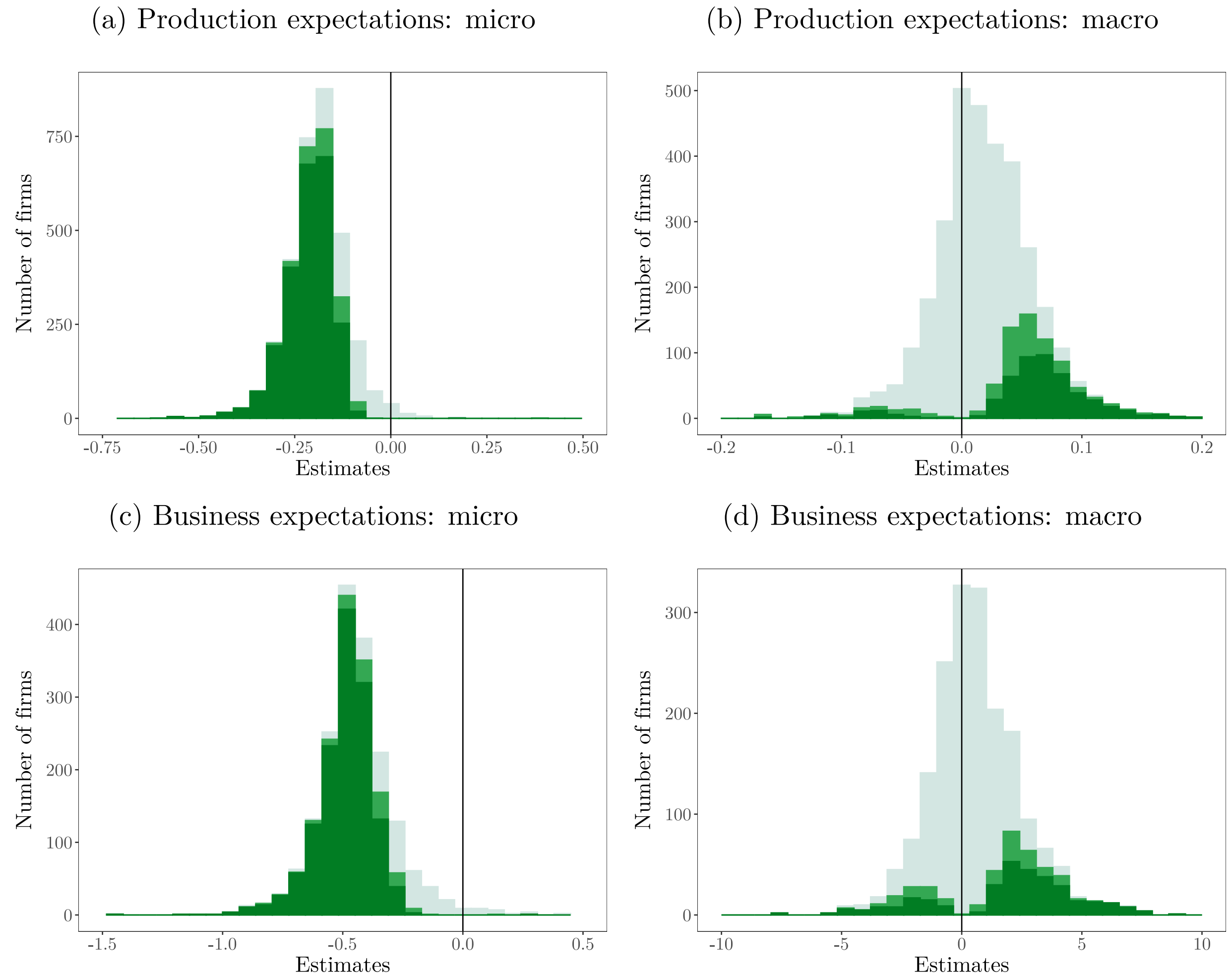
Notes: Regression results based on Equation (6); observations are pooled across firms, specification includes firm-fixed effects. Panel (a) shows results for the production expectations (three months horizon, qualitative data), and Panel (b) for the business situation (six months horizon, quantitative data). Micro news are forecast revisions net of time-fixed effects, macro news the surprise component of the ifo index. Column (4) uses raw forecast revisions as a measure of micro news (no time-fixed effect removed). All specifications include firm-fixed effects and standard errors clustered at the firm level. *** p<0.01, ** p<0.05, * p<0.1.

forecast error). The average absolute size of macro news is 0.971 and leads to an increase in the absolute value of the forecast error by 0.02 (0.05 standard deviations of the forecast error). Hence, the effects on forecast errors are not negligible, and the micro coefficient is about 2-3 times stronger than the macro coefficient.

The remaining columns in the top panel of the table confirm the results reported in column (1): the micro coefficient remains negative and highly significant when excluding macro news (second column). This is to be expected because micro news are by construction purged of the time-series variation. The macro coefficient remains positive and significant when including only macro news in the regression (third column) or when using raw forecast revisions to measure micro news (fourth column).

The results in Table 2 are based on estimates for which we pool observations across firms.

Figure 2: Distribution of firm-level of responses to news



Notes: Top panels show results for production expectations (three months horizon, qualitative data), bottom panels for expectations about firms' business situation (six months horizon, quantitative data). Grey area represents insignificant estimates, light green area represents estimates significant at the 10% level, dark green area indicates significance at the 5% level.

But we may exploit the fact that there is a sufficient number of time-series observations for each firm in order to estimate the reaction to news at the level of individual firms. To this end, we re-estimate our baseline specification (6) for each of the 3,000 firms in our sample and report results in Figure 2.[5] The top panels show the distribution of estimates for β_1 and β_2 based on production expectations. These coefficients capture the response to micro and macro news, respectively. There is a clear pattern: the mass of the estimates for β_1 is concentrated to the left of zero. In fact, as panel (a) shows, most estimates are significantly smaller than zero (dark green bars). Specifically, for the subset of significant estimates, the

[5]As discussed in Section 2, our sample includes only firms with at least 30 monthly observations and some variation in their production expectations and forecast errors.

micro coefficient is negative for more than 99 percent of firms. The estimates for β_2 instead are centered to the right of zero. In this case, estimates are not always significantly different from zero (grey bars), but when we consider significant estimates only, the macro coefficient is positive for 89 percent of firms. Overall, the results show that (a) the reaction to news varies substantially across firms and (b) our results for the regression which pools observations hold up once we consider firm-level estimates: the micro coefficient is generally negative while the macro coefficient tends to be positive. Given our discussion above, the interpretation is straightforward: firms overreact to micro news and tend to underreact to macro news. In subsection 3.3 below, we zoom in on how the reactions depend on specific firm characteristics.

A distinct feature of our baseline specification is that it relies on qualitative responses of firms: they report whether they expect production to increase, stay the same, or decline. We now turn to a quantitative measure of firm expectations which is also elicited by the ifo survey. It pertains to firms' business situation over the next six months and answers are provided in a range from 0 (rather less favorable) to 100 (rather favorable). Correspondingly, the survey also asks about the current business situation, with possible answers ranging from 0 (bad) to 100 (good), which allows us to compile a time series of forecast errors just like for production expectations. We may thus compile forecast errors for the expected business situation over a six months period, analogously to forecast errors for production expectations.[6] Micro and macro news are measured the exact same way as above, except that micro news are measured in terms of revisions in business expectations instead of production.

We report results based on firms' business expectations in panel (b) of Table 2. As before for firm expectations about production (reported in panel (a)) we find that firms overreact to micro news but underreact to macro news. Moreover, this holds also across the alternative specifications in columns (1) to (4) of the table. This is notable since not only does the nature of responses (qualitative v quantitative) vary across the panels, but also the time horizon (three v six months) and economic concept (production v business situation). With regards to the latter, we note that production expectations are more precisely defined—hence our choice for the baseline specification.[7] Yet, we also report firm-level estimates based on the business situation in the bottom panels of Figure 2 and detect a very similar pattern as in the top panels: when it comes to business expectations, overreaction to micro news is pervasive at the firm level, while firms tend to underreact to macro news.

In what follows, we vary specific aspects of the baseline specification and summarize the

[6] Link (2020) argues that answers pertain to the level of the expected business situation rather than the change. We use the level interpretation in the baseline but also account for the possibility that business expectations reflect changes. We find that our results are robust to both specifications, see Table A.2h.

[7] In addition, the quantitative business situation is only elicited for a subset of firms, starting in September 2005. This accounts for a reduction in the sample size by almost 50 percent.

Table 3: Alternative specifications

Aspect (Baseline)	Variation	Details	Micro coeff.	Macro coeff.
1) Estimation (OLS)				
	ordered logit	Table A.2a	-1.16^{***}	0.100^{***}
2) Forecast error (Bachmann et al. 2013)				
	set small errors ($\pm\frac{1}{3}$) to zero	Table A.2b	-0.117^{***}	0.018^{***}
	above only for no-change expectations	Table A.2c	-0.180^{***}	0.017^{***}
3) Micro News (Forecast Revisions)				
	use only revisions towards zero	Table A.2d	-0.096^{***}	0.029^{***}
	above and set small errors ($\pm\frac{1}{3}$) to zero	Table A.2e	-0.076^{***}	0.023^{***}
4) Macro News (surprise component in ifo index)				
	surprise component in manuf. orders	Table A.2f	-0.194^{***}	0.005^{***}
	first difference of ifo index	Table A.2g	-0.194^{***}	0.001^{***}
	average forecast revision	Table A.2g	-0.194^{***}	0.308^{***}
	average forecast revision by sector[a]	Table A.2g	-0.196^{***}	0.129^{***}
5) Macro component of forecast revision (fixed effect by time)				
	fixed effect by time and sector	Table A.2g	-0.196^{***}	0.021^{***}

Notes: Variations of baseline regression setup. Each column corresponds to an alternative of the baseline results for Equation 6 in Table 2. Micro coefficient and Macro coefficient are the estimates on micro and macro news. [a] In this specification, the macro component of forecast revisions is the time and sector average, which in turn are used as macro news. *** p<0.01, ** p<0.05, * p<0.1.

results in Table 3. First, recall that our baseline results are based on OLS and the Bachmann et al. (2013) definition of qualitative production forecast errors, see Equation (1). Macro news are the surprise component of the ifo index, and the macro component of forecast revisions is the mean over the entire cross-section. The first panel shows that our results also hold when we treat forecast errors qualitatively and use ordered logit rather than OLS for the estimation. The second panel addresses concerns about measurement error. First, in the construction of forecast errors, we set all small forecast errors to zero and thereby consider large forecast errors only. Second, to maintain more variation in forecast errors, we set small forecast errors to zero, when firms expect ‘no change’ in production. In both cases, the findings for the baseline specification are confirmed. The third panel estimates the baseline specification on a subsample of observations where firms revise their production expectations to zero to ensure that the results are not mechanically biased by the qualitative revision scale. The overreaction to micro news is still present. The result also holds when we additionally set small forecast errors to zero. The fourth panel varies the definition of macro news. Our results also hold when we consider alternative measures for macro news. We find, in particular, underreaction to the surprise component in manufacturing orders, the first difference of the ifo index, the average forecast revision, or the average forecast revision per sector. The fifth panel shows the results from considering the sectoral forecast revision as macro components rather than the overall mean forecast revision.

3.3 Accounting for heterogeneity

Figure 2 shows that firms differ in how they react to news. To investigate this more systematically, we zoom in on the determinants of the response to micro and macro news. For this purpose, we re-run the pooled regressions from Table 2 while adding interaction terms that capture heterogeneity, both along the cross-sectional and time-series dimensions. We use a Wald test to check if these interaction terms are statistically different from each other. Along the cross-section, we consider the number of employees, firm age, and the duration for which firms participate in the survey. More specifically, for the number of employees, we distinguish between firms in different quartiles; for firm age, we split between firms below 20 years of age and older firms, where a firm's age is measured at the time of the survey based on the year of the reported incorporation; and for the time in the survey, we distinguish between responses submitted during and after the first six months of being in the survey. In addition, we consider heterogeneity regarding the self-reported importance of the business cycle for the firms (see Table A.1 for the wording of the question). Finally, along the time-series dimension, we distinguish between positive and negative news and the period during (outside) the Great Recession.

Table 4 displays the results. To facilitate the comparison, we reproduce the results for the baseline in the top panel: On average firms overreact to micro news (measured by negative news coefficients) and underreact to macro news (positive news coefficients). We find that this pattern holds across interaction terms. The micro coefficient is robustly negative in the cross-section and not significantly different across different levels of firm size, firm age, time in the survey, and importance of the business cycle. This is consistent with the evidence in panel (a) of Figure 2 which shows that the firm-level estimates for β_1 cluster in a fairly tight range. Along the time-series dimension, the micro coefficient is significantly larger for positive news compared to negative news and during the Great Recession compared to other periods.

For the response to macro news, in turn, we find sizeable and significant heterogeneity for firm size, time in the survey, the sign of news and the Great Recession, again consistent with the more widely distributed estimates of β_2 shown in panel (b) of Figure 2. Looking at firm

Table 4: Heterogeneity

		Micro News			Macro News		
Interaction	N	$\widehat{\beta}_j$	$SE(\widehat{\beta}_j)$	W	$\widehat{\beta}_j$	$SE(\widehat{\beta}_j)$	W
(1) News	302,737						
Overall		-0.194^{***}	0.001		0.021^{***}	0.001	
(2) News	302,737			0.384			0.000
× 1. Quartile by employees		-0.199^{***}	0.003		0.012^{***}	0.003	
× 2. Quartile by employees		-0.193^{***}	0.003		0.019^{***}	0.002	
× 3. Quartile by employees		-0.192^{***}	0.003		0.021^{***}	0.001	
× 4. Quartile by employees		-0.195^{***}	0.002		0.026^{***}	0.001	
(3) News	162,776			0.316			0.362
× Firm age < 20 years		-0.187^{***}	0.006		0.018^{***}	0.003	
× Firm age ≥ 20 years		-0.193^{***}	0.002		0.020^{***}	0.001	
(4) News	302,737			0.913			0.045
× Time in survey < half a year		-0.195^{***}	0.008		0.032^{***}	0.006	
× Time in survey ≥ half a year		-0.194^{***}	0.001		0.021^{***}	0.001	
(5) News	129,053			0.857			0.188
× Low business cycle importance		-0.190^{***}	0.002		0.018^{***}	0.001	
× High business cycle importance		-0.191^{***}	0.005		0.022^{***}	0.002	
(6) News	302,737			0.019			0.000
× Positive sign of news		-0.199^{***}	0.002		0.011^{***}	0.001	
× Negative sign of news		-0.189^{***}	0.002		0.034^{***}	0.001	
(7) News	302,737			0.000			0.000
× outside Great Recession		-0.191^{***}	0.001		0.016^{***}	0.001	
× during Great Recession		-0.211^{***}	0.003		0.039^{***}	0.002	

Notes: Baseline regression (Equation (6)) estimated on the full, pooled sample. All regressions include micro and macro news with interaction terms and firm-fixed effects. Standard errors are clustered at the firm level. N is the number of observations, $\widehat{\beta}_j$ is the point estimate and SE($\widehat{\beta}_j$) is its standard error. Column W reports the p-value for the null that the news coefficients are jointly the same. We run the Wald test separately for each type of news. For (quartiles of) the number of employees, we rely on annual questions in the ifo survey. For firm age, we rely on a one-time question about the year the firm was founded. To compute the firm age, we subtract from the year of response the year of foundation. For the Great Recession, we rely on a dummy equal to 1 during the years 2007 to 2008 and 0 else. For business cycle importance, we rely on a one-time question, where firms rank the importance of general economic developments in Germany for their business on a five-point scale from very important [1] to unimportant [5]. Business cycle importance is high when the response was very important. *** p<0.01, ** p<0.05, * p<0.1.

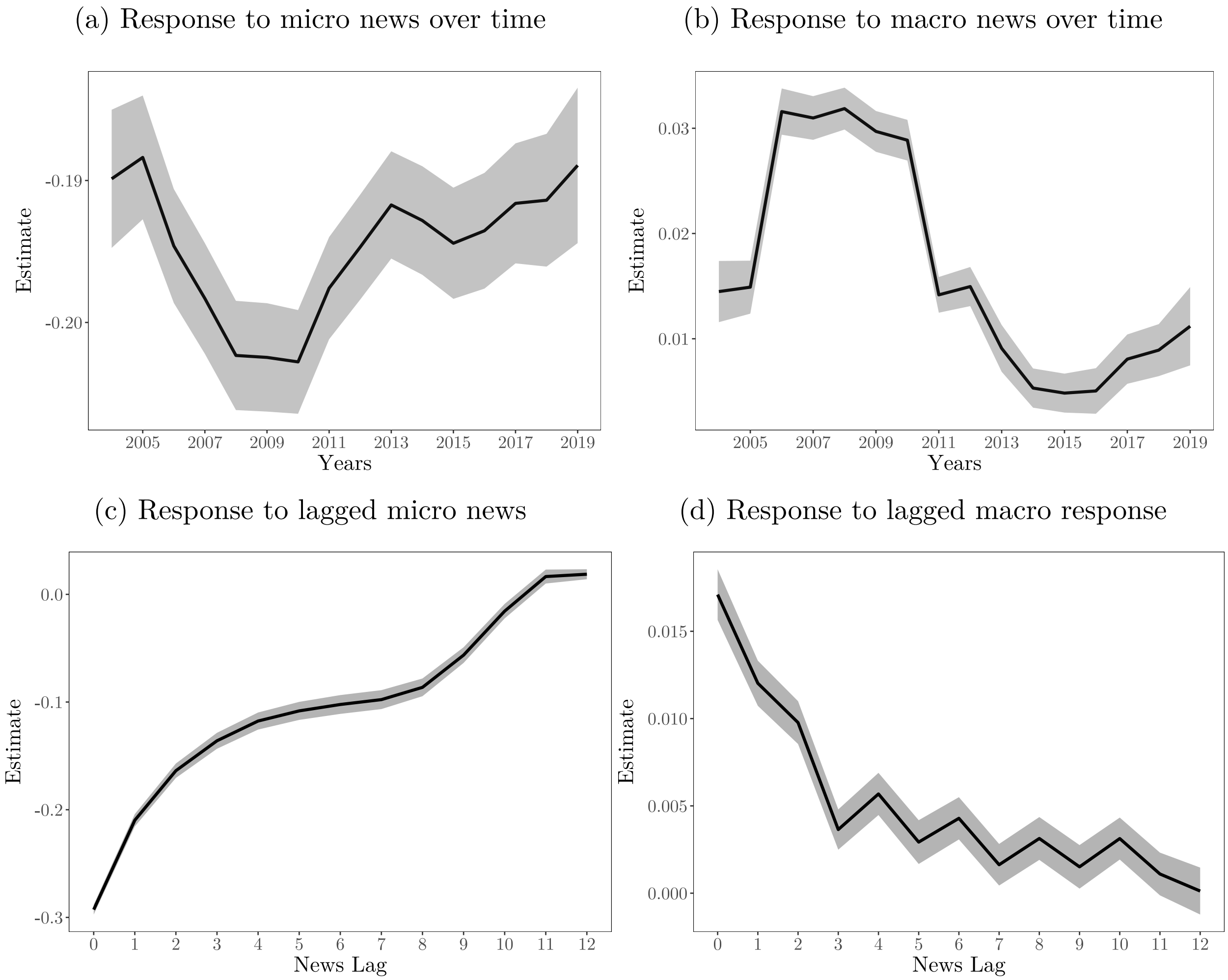
size (panel (2) of Table 4), the underreaction to macro is news is strictly and statistically significantly increasing across employee quartiles. The underreaction of the largest firms is twice as strong as that of the smallest firms. This result may reflect a stronger impact of the macro economy on the production—and hence the forecast errors—of larger firms. Regarding firm age (panel (3)), there is no statistical difference in the response to macro news between young and old firms. So there is no evidence that firms learn simply by getting older.[8] When comparing the underreaction of firms that recently joined the survey (six months) to firms with longer tenure (panel (4)), we find evidence for "learning through survey" (Kim and Binder 2021). The underreaction among more tenured firms is about one-third smaller than for firms that recently joined the survey and is statistically significant. This finding is also in line with Massenot and Pettinicchi (2018), who find, for example, that firms' absolute forecast errors about their own business situation decrease as time since entry in the ifo survey passes. For the importance of the business cycle (panel (5)) we distinguish between firms that rank the business cycle as very important to them and all other firms. Here, in line with the heterogeneity by firm size, a high business cycle importance is associated with a larger underreaction. However, the difference is not statistically significant. Turning to the time-series dimension, we find the underreaction to macro news to be countercyclical. First, the underreaction to negative news is about three times stronger than in the case of positive news (panel (6)) and significantly so. Second, the underreaction is much stronger during the Great Recession (panel (7)) and significantly different from the remaining sample period. To explore the issue further we estimate the baseline specification on 5-year rolling windows, following again Coibion and Gorodnichenko (2015)

Figure 3 shows the results. Panel (a) and (b) show how the estimated response coefficients for micro and macro news evolve over time. A number of observations are in order. First, firms overreact to micro news and underreact to macro news over the entire sample. Second, the deviations from the rational expectations benchmark are largest during the Great Recession. Third, for macro news, the variation over time appears to be substantial in economic terms: the underreaction is about three times as large during the Great Recession compared to non-recession periods. Taken at face value, this pattern conflicts with the notion of rational inattention because one would expect firms to pay more attention to the aggregate economy in times of crisis (see also, Flynn and Sastry 2022). Yet, as argued above, the increased underreaction may simply reflect a stronger impact of macro variables on firm outcomes.

Our focus is on the immediate reaction of expectations to news. Still, we explore to which extent over- and underreaction to news persists over time. For this purpose, we regress the

[8] For instance, Farmer et al. (2021) show that Bayesian learning can potentially explain forecasting anomalies in professional forecasts of aggregate variables.

Figure 3: Response to news over time



Notes: Top panels show estimates based on 5-year rolling windows. Bottom panels show estimates for response to contemporaneous and lagged news, see Equation (7). Black lines represent point estimates, grey areas correspond to 95% confidence intervals.

forecast error on lagged news in addition to current news. This approach is more suitable than local projections since news may be autocorrelated.[9] Specifically, we estimate a model which features 12 lags of both micro and macro news:

$$x^i_{t+3,t} - F^i_t(x^i_{t+3,t}) = \beta_0 + \sum_{p=0}^{12}(\beta_{1,p} \cdot \text{micro news}^i_{t-p} + \beta_{2,p} \cdot \text{macro news}_{t-p}) + \mu_i + v^i_t \ . \quad (7)$$

We show results in the bottom panels of Figure 3. The overreaction and underreaction is strongest for concurrent news but persists over time. Only after about one year, news cease

[9]And indeed, we find that—since micro (macro) news are negatively (positively) autocorrelated—the micro (macro) coefficient on current news is larger (smaller) in this set-up compared to the baseline.

to be a cause of forecast errors. This holds both for micro news (panel c)) and macro news (panel (d)).

Finally, we ask what the joint distribution of firm-level response coefficients for micro and macro news looks like. To this end, we relate the firm-level estimates of micro and macro news (illustrated in Figure 2). Figure A.2 in the appendix displays a binned scatterplot between the micro and macro news coefficients. Indeed, we find a negative relation ($\rho = -0.14$). Hence, the stronger the underreaction to macro news of a given firm, the stronger is also the overreaction to micro news.

In sum, overreaction to micro news and underreaction to macro news is a robust and pervasive phenomenon—across firms and states of the world.

3.4 Reaction to news and real activity

Expectations matter for firm decisions and firm outcomes, as Enders et al. (2022) establish specifically for the ifo data set. Against this background, we investigate whether over- and underreaction to news is related to measures of firm performance in a systematic way. Specifically, we relate the estimated response coefficients for each firm to their return on sales and their production volatility. We rely on the firm-level estimates discussed in Section 3.2 above and restrict the sample to firms that overreact to micro news and underreact to macro news, in line with the aggregate findings.

Since 2009, the ifo Business Climate Survey includes a quantitative question on return to sales in the current year.[10] For each firm, we calculate the average return on sales and regress them on the micro and macro news coefficients estimated in Section 3.2. In addition, we absorb sector- and size-fixed effects. Columns (1) and (2) in Table 5 display the results. A stronger overreaction to micro news is associated with a significant decrease in average return on sales, while a stronger underreaction to macro news is not significantly related to the average return on sales. In terms of magnitude, a one standard deviation increase in the overreaction to micro news leads on average to a ≈ 0.16 percentage point reduction in return on sales.

As a second exercise, we calculate the standard deviation of qualitative realized production changes as a proxy for firm-level production volatility. Then, we follow the procedure above and regress it on the estimated response coefficients to micro and macro news, obtained in Section 3.2 above. Columns (3) and (4) in Table 5 display the results. The estimates indicate

[10]Return on sales is elicited in May and September. We rely on the September wave to capture a larger information set. In addition, we subtract the yearly average return on sales to ensure that the results are not confounded by heterogeneity over time (in a recession, returns are lower and underreaction stronger, see Section 3.3).

Table 5: Over- and underreaction to news and real activity

		$\text{mean}_i(\text{return on sales}_{it})$		$\text{sd}_i(\text{production}_{it})$	
	Sign of news coeff.	(1)	(2)	(3)	(4)
Constant		0.199		0.406***	
		(0.182)		(0.010)	
Reaction to micro news	$\beta_1 < 0$	1.76**	2.36***	-0.250***	-0.248***
		(0.876)	(0.842)	(0.045)	(0.046)
Reaction to macro news	$\beta_2 > 0$	-0.069	-0.363	1.66***	1.64***
		(1.85)	(1.83)	(0.097)	(0.098)
Observations		1,665	1,665	2,204	2,204
R^2		0.003	0.053	0.135	0.154
Within R^2			0.005		0.132
Sector and Size FE			✓		✓

Notes: Estimates from linear regressions of average return on sales (columns (1) and (2)) and production dispersion (columns (3)-(4)) of firms on the firm-level estimates of the micro and macro news coefficients. Standard errors are clustered at the firm level. *** p<0.01, ** p<0.05, * p<0.1.

a tight relation between production volatility and the over- and underreaction to news at the firm level. An increase in the overreaction to micro news is associated with higher volatility. While the point estimate is larger for micro news than for macro news, a one standard deviation increase in the respective bias increases output volatility slightly more for macro news. Projecting these cross-sectional estimates on the macro level implies higher micro-level volatility in presence of the over- and underreaction. This is a potential explanation for the high observed idiosyncratic volatility of firm outcome variables (Bachmann et al. 2013; Bloom 2009).

3.5 Further evidence for Italian firms

We now turn to an alternative survey of firm expectations in order to assess to what extent our results generalize beyond the ifo survey of German firms. Specifically, we rely on the Survey on Inflation and Growth Expectations (SIGE) operated by the Banca d'Italia. Two features of the SIGE are particularly noteworthy in the context of our analysis. First, it elicits answers in the form of growth rates which as such are quantitative (rather than qualitative as in our ifo baseline). Second, it asks firms about their expectations of aggregate developments, namely inflation, in addition to expectations about firm-specific developments.

We use the survey to reestimate our baseline specification (6), except that we now focus on firms' price expectations. To construct expectation errors and news, we follow our earlier strategy for the ifo survey as closely as possible. More specifically, we construct the one-year ahead expectation error for prices by subtracting from the realized change the change that

Table 6: Over- and underreaction to news—Italian firms

	Forecast error about firm's own prices					
	(1)	(2)	(3)	(4)	(5)	(6)
Micro News	-0.500***	-0.501***				-0.497***
	(0.030)	(0.030)				(.030)
Macro News	0.153**		0.255*		0.178**	
	(0.070)		(0.138)		(0.071)	
Micro News, raw				-0.494***	-0.493***	
				(0.029)	(0.296)	
Macro News, revision						0.299***
						0.080
Observations	14,385	14,385	14,385	14,385	14,385	14,520
Within R^2	0.1332	0.1327	0.001	0.1291	0.1297	0.1328
Firm FE	✓	✓	✓	✓	✓	✓

Notes: Regressing firms' forecast errors about their own prices on micro news defined as the forecast revisions net of time-fixed effects as well as macro news (first difference of firms' inflation expectation). Firm-fixed effects are included and standard errors (in parentheses) are clustered at the firm level. In columns (4) and (5), we consider as micro news the first difference of expected own price growth without removing time-fixed effects. In column (6), Macro news are the difference between the current six-months-ahead inflation expectation (Q4) and the one-year-ahead inflation six months ago (Q3), which is an actual forecast revision.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

firms report expecting 12 months earlier. In our baseline specification, micro news correspond, as before, to the forecast revision net of a time-fixed effect and macro news correspond to the first difference of one-year ahead inflation forecasts. We provide further details on the SIGE in Appendix B and show the estimation results in Table 6. They confirm our findings for the ifo survey: coefficients for micro news are negative and coefficients for macro news are positive and they are significant, both individually and jointly. This finding also holds when we consider the raw first difference of expected own price changes as micro news (see columns (4) and (5)). In column (6), we use firms' inflation forecasts at different time horizons to construct true revisions, where the forecast horizons completely overlap. More specifically, we subtract for firms' current six-months-ahead inflation forecast their one-year-ahead inflation expectation they reported six months ago. The coefficients show that overreaction to micro news and underreaction to macro news are also significant for this specification.

4 A model of island illusion

In the following, we develop a stylized model in order to rationalize the evidence established above. Specifically, in the model, we derive a microfoundation for our empirical specification (6) and establish conditions under which firm expectations overreact to micro news and underreact to macro news. Two aspects set our model apart from related theoretical work, some of which we reference in the introduction above. First, our focus is on expectations about a firm's own performance and how these, in turn, are shaped by micro and macro news. To capture these in a consistent manner, we need to specify a full-fledged general equilibrium model. Second, the distinct feature of our model is that firms suffer from 'island illusion'. As a result, firms systematically underestimate the importance of aggregate developments for their own performance. This appears plausible to the extent that for firms firm-specific developments are more salient of economic performance—consistent with findings according to which direct experience impacts (risk) perceptions more strongly than outcomes experienced by others (Smith et al. 2001; Viscusi and Zeckhauser 2015).

Our setup relates to Bordalo et al. (2020) where news are overly representative for forecasters and thus trigger an overreaction. Our model, however, accounts for simultaneous over- and underreaction to different types of news at the level of individual forecasters. What sets our model apart from the model of overconfidence put forward by Broer and Kohlhas (2022) is a general equilibrium perspective that accounts for the cross-equation restrictions regarding the impact of micro and macro news.

Formally, we build on the model with dispersed and noise information put forward by Lorenzoni (2009). We depart from the original model in two ways. First, we assume firms are subject to island illusion. Second, we simplify the original model by assuming predetermined rather than staggered prices in order to solve an approximate model in closed form and to derive analytical results. In what follows, we first describe the structure of the economy, including technology and preferences. Afterward we specify expectations and policy and present our main result regarding over- and underreaction.

4.1 Setup and timing

There is a continuum of islands (or locations), indexed by $l \in [0, 1]$, each populated by a representative household and a unit mass of producers, indexed by $j \in [0, 1]$. Each household buys from a subset of all islands, chosen randomly in each period. Specifically, it buys from all producers on n islands included in the set $\mathcal{B}_{l,t}$, with $1 < n < \infty$.[11] Households have an infinite planning horizon. Producers produce differentiated goods on the basis of island-specific productivity, which is simultaneously driven by a permanent, economy-wide component and a temporary, idiosyncratic component.[12] Household-specific demand also features an aggregate and an idiosyncratic stochastic component such that we can write in

[11]This assumption ensures that households cannot exactly infer aggregate productivity from observed prices. At the same time, individual producers have no impact on the price of households' consumption baskets.

[12]As argued by Lorenzoni (2009), this setup can account for the empirical observations that the firm-level volatility of productivity is large relative to aggregate volatility and that individual expectations are dispersed.

general terms:

$$\vartheta_{j,t} = \sqrt{\varpi_\vartheta}\vartheta'_t + \sqrt{1-\varpi_\vartheta}\bar{\vartheta}'_{j,t}, \tag{8}$$

Here $\vartheta_{j,t}$ is either technology of firm j or demand of household j, while ϑ'_t and $\bar{\vartheta}'_{j,t}$ are the aggregate and idiosyncratic components, respectively. Both are i.i.d. random variables. The weight ϖ_ϑ determines the importance of aggregate relative to idiosyncratic shocks. Relation (8) implies

$$Var(\vartheta_{j,t}) = Var(\vartheta'_t) = Var(\bar{\vartheta}'{}_{j,t}),$$

such that total volatility is divided between the aggregate contribution $\varpi_\vartheta Var(\vartheta_{j,t})$ and the idiosyncratic contribution $(1-\varpi_\vartheta)Var(\vartheta_{j,t})$.

The timing of events is as follows: Financial markets are complete such that, assuming identical initial positions, wealth levels of households are equalized at the beginning of each period. Each period consists of three stages. During stage one of period t, information about all variables of period $t-1$ is released. Subsequently, nominal wages are determined and the central bank sets the interest rate based on expected inflation. This interest rate may include a monetary policy shock. We view this disturbance as a generic shock that is observable, with the understanding that other observable shocks would play a comparable role.

The aggregate and idiosyncratic components of productivity materialize in the second stage. Concerning technology, firms only observe their own productivity (micro news). Additionally, a noisy public signal about the aggregate demand shock is released to firms and households, based on, say, market research (macro news). Given these information sets, producers set prices.

During the third and final stage, households split up. Workers work for all firms on their island, while consumers allocate their expenditures across differentiated goods based on public information and information contained in the prices of the goods in their consumption bundle. Additionally, individual demand shocks influence their consumption decisions. Because the common productivity component is permanent, demand shocks are purely temporary, and households' wealth and information are equalized in the next period, agents expect the economy to settle on a new steady state from period $t+1$ onward.

4.2 Households

A representative household on island l ("household l", for short) maximizes lifetime utility

$$U_{l,t} = E_{l,t}\sum_{\tau=t}^{\infty}\beta^{\tau-t}Q_{l,\tau}\ln C_{l,\tau} - \frac{L_{l,\tau}^{1+\varphi}}{1+\varphi} \qquad \varphi \geq 0, \quad 0<\beta<1,$$

where $E_{l,t}$ is the expectation operator based on household l's information set at the time of its consumption decision in stage three of period t (see below). $C_{l,t}$ denotes the consumption basket of household l, while $L_{l,t}$ is its labor supply. As described in Equation (8), the demand shock $Q_{l,t}$ consists of an aggregate and an island-specific component. In logs, this implies

$$q_{l,t} = \sqrt{\varpi_q} q_t' + \sqrt{1-\varpi_q} \bar{q}_{l,t}' \equiv q_t + \bar{q}_{l,t},$$

with $q_t = \sqrt{\varpi_q} q_t'$ and $\bar{q}_{l,t} = \sqrt{1-\varpi_q} \bar{q}_{l,t}'$, where q_t' and $\bar{q}_{l,t}'$ are i.i.d. shocks with mean zero and variance $Var(q_t') = Var(\bar{q}_{l,t}') = Var(q_{l,t})$. While actual demand, including the shocks, realizes only in stage three of the period, a public signal about the (weighted) aggregate component is released to firms and households in the second stage, representing macro news:

$$s_t = q_t + e_t,$$

where e_t is an i.i.d. noise shock with variance σ_e^2 and mean zero. The flow budget constraint of the household is given by

$$E_t \varrho_{l,t,t+1} \Theta_{l,t} + B_{l,t} + \sum_{m \in \mathcal{B}_{l,t}} \int_0^1 P_{j,m,l,t} C_{j,m,l,t} dj \leq \int_0^1 \Pi_{j,l,t} dj + W_{l,t} L_{l,t} + \Theta_{l,t-1} + (1 + r_{t-1}) B_{l,t-1},$$

where $C_{j,m,l,t}$ denotes the amount bought by household l from producer j on island m and $P_{j,m,l,t}$ is the price for one unit of $C_{j,m,l,t}$. At the beginning of the period, the household receives the payoff $\Theta_{l,t-1}$, given a portfolio of state-contingent securities purchased in the previous period. $\Pi_{j,l,t}$ are the profits of firm j on island l and $\varrho_{l,t,t+1}$ is household l's stochastic discount factor between t and $t+1$. The period-t portfolio is priced conditional on the (common) information set of stage one, hence we apply the expectation operator E_t. $B_{l,t}$ are state non-contingent bonds paying an interest rate of r_t. The complete set of state-contingent securities is traded in the first stage of the period, while state-non-contingent bonds can be traded via the central bank throughout the entire period. The interest rate of the non-contingent bond is set by the central bank. All financial assets are in zero net supply. The bundle $C_{l,t}$ of goods purchased by household l consists of goods sold in a subset of all islands in the economy

$$C_{l,t} = \left(\frac{1}{n} \sum_{m \in \mathcal{B}_{l,t}} \int_0^1 C_{j,m,l,t}^{\frac{\gamma-1}{\gamma}} dj \right)^{\frac{\gamma}{\gamma-1}} \qquad \gamma > 1.$$

While each household purchases a different random set of goods, we assume that all households visit the same number of islands n. The price index of household l is therefore

$$P_{l,t} = \left(\frac{1}{n} \sum_{m \in \mathcal{B}_{l,t}} \int_0^1 P_{j,m,l,t}^{1-\gamma} dj \right)^{\frac{1}{1-\gamma}}.$$

4.3 Producers

Producer j on island l produces according to the following production function

$$Y_{j,l,t} = A_{j,l,t} L_{j,l,t}^{\alpha} \qquad 0 < \alpha < 1,$$

featuring labor supplied by the local household as the sole input. $A_{j,l,t} = A_{l,t}$ denotes the productivity level of producer j, which is the same for all producers on island l. During stage two, the producer sets the optimal price for the current period. Given prices, the level of production is determined by demand during stage three. Since each island is visited by n consumers, producer's j on island l total demand, is given, in logs, by

$$q_{j,l,t} = q_t + \sum_{\{m | l \in \mathcal{B}_{m,t}\}} \frac{\bar{q}_{m,t}}{n}.$$

Log-productivity on each island $a_{l,t}$ depends on last period's aggregate technology x_{t-1}, an aggregate shock, and an island-specific shock:

$$a_{l,t} - x_{t-1} = \sqrt{\varpi_a} a'_t + \sqrt{1 - \varpi_a} \bar{a}'_{l,t} \equiv \varepsilon_t + \eta_{l,t},$$

with $\varepsilon_t = \sqrt{\varpi_a} a'_t$ and $\eta_{l,t} = \sqrt{1 - \varpi_a} \bar{a}'_{l,t}$, where a'_t and $\bar{a}'_{l,t}$ are i.i.d. shocks with mean zero and variance $Var(\bar{a}'_{l,t}) = Var(a'_t) = Var(a_{l,t} - x_{t-1})$. The shock $a'_{l,t}$ (and therefore also $\eta_{l,t}$) aggregates to zero across all islands. Idiosyncratic productivity thus contains private information (micro news) about the aggregate level of technology x_t, which follows a random walk

$$\Delta x_t = \sqrt{\varpi_a} a'_t \equiv \varepsilon_t.$$

Producers only observe productivity on their own island $a_{l,t}$.

4.4 Island illusion

We now turn to the details of the expectation-formation process. To set island illusion apart from rational expectations, we first specify the rational forecasts.

Producers. The rational forecast for Δx_t is given by

$$\bar{E}_{j,l,t}\Delta x_t = \bar{\delta}^p_x (a_{l,t} - x_{t-1}),$$

where $\bar{E}_{j,l,t}$ is the rational expectation of producer j on island l when setting prices (in stage two). The coefficient $\bar{\delta}^p_x$ is a function of the structural parameters that capture the informational friction. It is non-negative and smaller than unity:

$$\bar{\delta}^p_x = \frac{\sigma^2_\varepsilon}{\sigma^2_\varepsilon + \sigma^2_\eta} = \varpi_a. \tag{9}$$

The rational forecast for q_t is given by

$$\bar{E}_{j,l,t} q_t = \bar{\rho}^p_q s_t, \qquad \text{with} \qquad \bar{\rho}^p_q = \frac{\sigma^2_q}{\sigma^2_q + \sigma^2_e} = \varpi_q.$$

Rather than assuming that all expectations are formed in a rational way, however, we suppose that producers are subject to island illusion. Specifically, we assume that producers underestimate the importance of aggregate developments, relative to idiosyncratic developments. Put differently, producers think that their own technology and the demand for their product are driven less by aggregate developments than under rational expectations. In our setup island illusion is governed by a single parameter Υ which downweighs the importance of the aggregate component relative to the actual weight:

$$\hat{\varpi}_\vartheta = \Upsilon \varpi_\vartheta.$$

Here $\hat{\varpi}_\vartheta$ is the weight ϖ_ϑ as perceived by producers and Υ measures the degree of the bias. If $\Upsilon = 1$, producers weigh the importance of both components correctly, while $\Upsilon < 1$ reflects island illusion (and $\Upsilon > 1$ the hypothetical case of 'continent illusion'). Thus, actual firm expectations are formed according to

$$E_{j,l,t}\Delta x_t = \delta^p_x (a_{j,l,t} - x_{t-1}) \qquad\qquad E_{j,l,t} q_t = \rho^p_q s_t,$$

with

$$\begin{aligned}
\delta^p_x &= \hat{\varpi}_a = \Upsilon \varpi_a < \varpi_a = \bar{\delta}^p_x \\
\rho^p_q &= \hat{\varpi}_q = \Upsilon \varpi_q < \varpi_q = \bar{\rho}^p_q.
\end{aligned}$$

Consumers. Regarding consumers, we assume that they form rational expectations in the following way. While shopping during stage three, they observe a set of prices. They can hence infer the productivity level of each producer in their sample:

$$E_{l,t}\Delta x_t = \delta_x^h \tilde{a}_{l,t},$$

where $\tilde{a}_{l,t}$ is the average over the realizations of $a_{m,t} - x_{t-1}$ for each island m in household l's sample $\mathcal{B}_{l,t}$. δ_x^h is equal across households, see Appendix C. Consumers have complete information if $n \to \infty$. Furthermore, households rationally incorporate the information contained in the public signal concerning the aggregate demand shock into their expectations of the aggregate price level, see Appendix C.

4.5 Monetary policy and market clearing

The central bank follows an interest-rate feedback rule but sets r_t before observing prices, that is during stage one of period t:

$$r_t = \psi E_{cb,t}\pi_t + \nu_t \qquad \psi > 1,$$

where π_t is economy-wide net inflation, calculated on the basis of all goods sold in the economy. The expectation operator $E_{cb,t}$ is conditional on the information set of the central bank. This set consists of information from period $t-1$ only, that is, the central bank enjoys no informational advantage over the private sector.[13] ν_t is a monetary policy shock that is observable by producers and households alike.

Goods and labor markets clear in each period:

$$\int_0^1 C_{j,m,l,t}dl = Y_{j,m,t} \ \ \forall j, m \qquad L_{l,t} = \int_0^1 L_{j,l,t}dj \ \ \forall l,$$

where $C_{j,m,l,t} = 0$ if household l does not visit island m. The asset market clears in accordance with Walras' law.

[13] Pre-set prices and interest rates allow us to discard the noisy signals about quantities and inflation observed by producers and the central bank in Lorenzoni (2009), simplifying the signal-extraction problem without changing the qualitative predictions of the model. Pre-set wages, on the other hand, guarantee the determinacy of the price level. They do not affect output dynamics after noise and technology shocks, because goods prices may still adjust in the second stage of the period.

4.6 Over- and underreaction

We derive a solution of the model based on a linear approximation to the equilibrium conditions around the symmetric steady state; see Appendix C for details. Lower-case letters denote percentage deviations from steady state. In the following, $\Delta y_{j,l,t}$ is the change of output of firm j on island l between periods $t-1$ and t. $FE_{j,l.t} = \Delta y_{j,l,t} - E_{j,l,t}\Delta y_{j,l,t}$ is the forecast error of the same firm. $FR_{j,l,t} = E_{j,l,t}y_{j,l,t} - E_t y_{j,l,t}$ represents the change in the forecast of the same firm regarding output growth between stage one and stage two of period t, that is, before and after having received the private and public signals. We obtain the following proposition, for which we provide proofs in Appendix D. It shows that assuming island illusion, that is $\Upsilon < 1$, generates overreaction to private signals and underreaction to public information by individual firms.

Proposition 1. *Consider the regression*

$$FE_{j,l.t} = \beta FR_{j,l,t} + \delta s_t + \omega_{j,l,t}. \tag{10}$$

where $FE_{j,l.t}$ is the forecast error of firm j on island l regarding its own output growth, $FR_{j,l,t}$ is the forecast revision thereof by the same firm, and $\omega_{j,l,t}$ represents a potential error term. In the case of island illusion, we obtain

$$\beta < 0 \qquad \textit{and} \qquad \delta > 0,$$

where β measures the firm's reaction to micro news and δ the reaction to macro news.

Intuitively, in a rational-expectations framework, individual future forecast errors cannot be predicted by current forecast revisions ($\beta = 0$) or public signals ($\delta = 0$), as firms could otherwise easily improve on their forecasts.[14] However, given that in our model firms suffer from island illusion and therefore underestimate the importance of aggregate developments, they place too little weight on the private signal ($\delta_x^p < \bar{\delta}_x^p$) when revising their forecast of aggregate technology, relative to the rational-expectations benchmark. Hence, on average, firms attribute too little weight to aggregate technology when they observe a positive surprise in their own technology. Put differently, after a successful technological innovation at their own firm, managers underestimate the potential of competitors to implement a similar reduction in costs. Hence they overestimate how much their own production will change, yielding $\beta < 0$.[15]

[14] To be precise, $\beta = \delta = 0$ as long as agents have a correct estimate of the relative variances of the components of the signals, see the proof of Proposition 1.

[15] To be precise, in general equilibrium, there are two, partly offsetting effects: on the one hand, firms expect

Regarding the effect of the public signal on firms' forecast error, firms again underestimate the role of aggregate developments. That is, they deem aggregate demand disturbances q_t to fluctuate less than they actually do. At the same time, they correctly observe the volatility of the signal, such that they overassess the contribution of noise to the signal. Consequently, they pay less attention to the signal than under the rational-expectations benchmark ($\rho_x^p < \bar{\rho}_x^p$). Following a positive signal, they hence underestimate the increase in demand for their own and their competitors' products. Hence, firms expect their own demand and the prices of competitors to be lower than they, on average, realize after a positive signal and therefore underestimate their own output, such that $\delta > 0$.

The model allows us to derive a number of additional predictions which conform well with the pattern in the data, established in Section 3 above. We discuss them in turn. As before, proofs are found in Appendix D.

Proposition 2. *A higher degree of island illusion (a lower Υ) implies*

(a) A stronger overreaction to micro news (a lower β) and simultaneously a larger underreaction to the public signal (a larger δ).

(b) Lower expected profits.

(c) A larger variance of the firm-specific forecast error.

Intuitively, if firms underestimate aggregate developments, they, as explained above, underestimate the information content of the public signal and simultaneously overestimate their technological advantage in case of positive developments in their idiosyncratic technology. Given that the optimal forecast (that achieves an expected forecast error of zero, seen from an econometrician's view) obtains for $\Upsilon = 1$, any deviations lead to biased forecasts in the profit maximization problem of the firm and hence lower expected profits. Likewise, it raises the forecast-error variance.

Proposition 3. *A higher attachment to the business cycle (a higher ϖ_q) leads to a larger underreaction to macro news (a larger δ).*

For firms that are more dependent on aggregate demand conditions, a higher degree of island illusion matters more, inducing a stronger underreaction. Intuitively, if demand for a

prices of competitors to be on average higher than what they will actually turn out, increasing expected demand for the firms' products. On the other hand, firms expect overall demand to be lower than warranted, reducing expected idiosyncratic demand as well. Overall, the first effect dominates, and firms on average overestimate their future sales after having observed a negative surprise in idiosyncratic technology.

firm's products is entirely idiosyncratic ($\varpi_q = 0$), island illusion does not play any role as it biases the estimated $\hat{\varpi}_q$ towards zero. For those firms, being on an island is no illusion but reality.

5 Conclusion

How do expectations adjust to news about the economy? We address this question while zooming in on firms' expectations about their own performance. This focus sets our study apart from earlier work, as does the distinction between micro and macro news. Analyzing firm surveys from Germany and Italy, we find robustly that firm expectations overreact to micro news and underreact to macro news. We rationalize these patterns based on a stylized general equilibrium model which assumes that firms suffer from island illusion: They perceive of what's happening to them as less common than it actually is. In the model, island illusion is governed by a single parameter, representing a disciplined departure from rational expectations. Assessing its validity in other contexts of expectation formation seems a promising avenue for future research.

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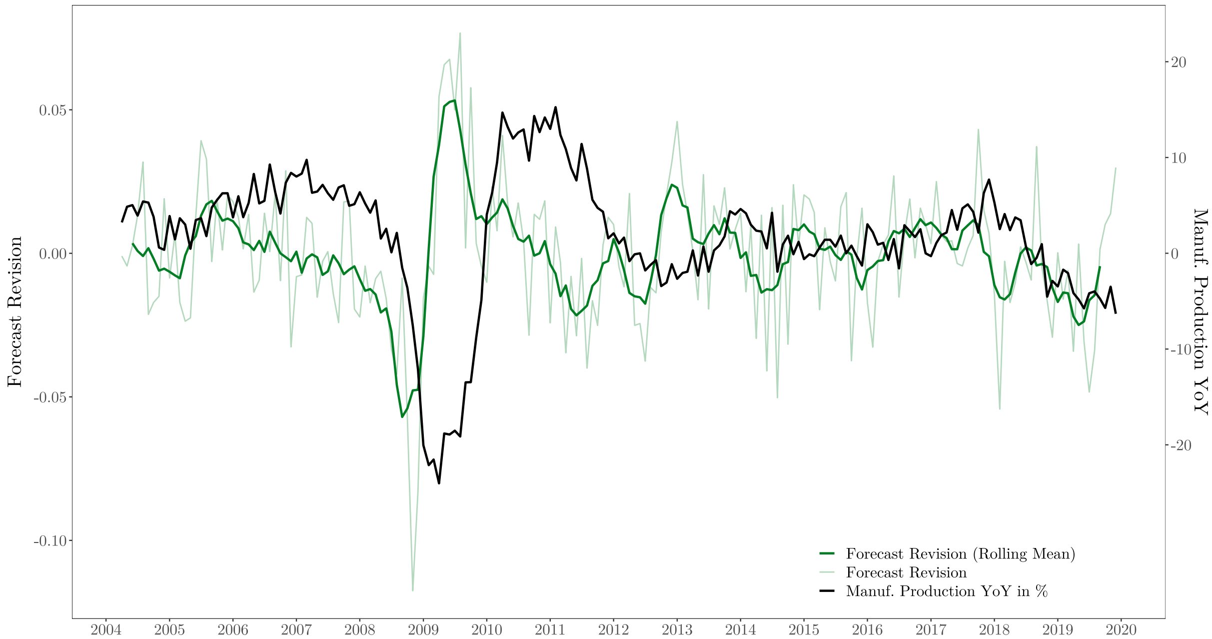
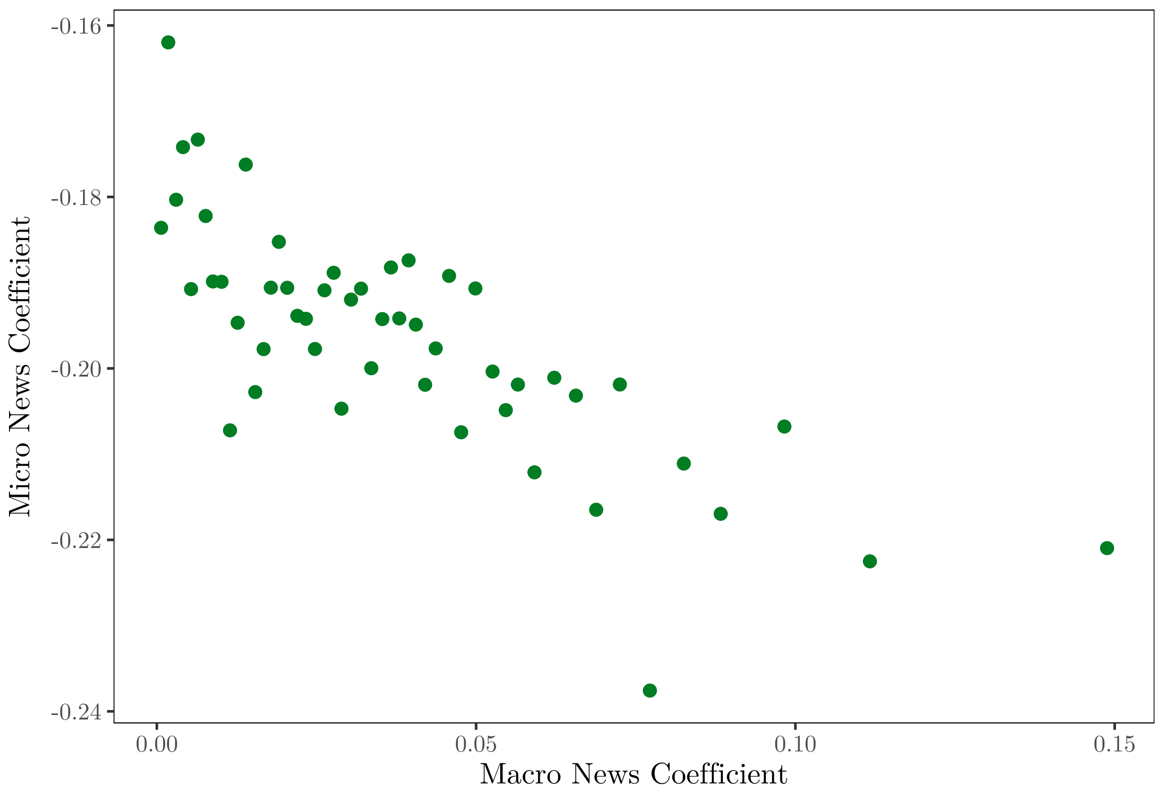
A Appendix

Figure A.1: Average forecast revisions and production growth



Notes: The figure displays the average, seasonally adjusted forecast revision (rolling mean over 6 months) in green and year-on-year growth of manufacturing production in black (administrative data).

Figure A.2: Relation between macro and micro bias at the firm-level



Notes: The figure displays a binned scatter plot (50 bins) between firm-level macro news bias and macro new bias. The firm-level estimates are also displayed in Figure 2.

Table A.1: Relevant questions from ifo survey

Label	Name	Question	Possible answers
Q1	Expected state of business (qualitative)	Plans and Expectations for the next 6 months: Our business situation will be	rather more favorable [1] not changing [0] rather less favorable [-1]
Q2	Expected state of business (quantitative)	Expectations for the next 6 months: In cyclical regards our state of business will be	slider with range 0 [be rather less favorable] to 100 [rather more favorable]
Q3	Realized state of business (qualitative)	Current situation: We evaluate our state of business to be	good [1] satisfiable [0] bad [-1]
Q4	Realized state of business (quantitative)	Current situation: We consider our state of business to be	slider with range good [100] to bad [0]
Q5	Realized production	Review - tendencies in [t-1]: Compared to [t-2] our production	increased [1] stayed about the same [0] decreased [-1]
Q6	Expected production	Plans and Expectations for the next 3 months: Our production is expected to be	increasing [1] not changing [0] decreasing [-1]
Q7	Macro importance	How important is the general economic development in Germany for your business situation?	very important [1] important [2] not as important [3] less important [4] unimportant [5]

Notes: Most recent wording of relevant questions from the ifo survey taken from the EBDC Questionnaire manual. t denotes the month of the survey, so in July Q5 asks about the change in June compared to May.

Table A.2: Alternative specifications

(a) Estimation: Ordered Logit rather than OLS

Term	Estimate	Standard Error	t-value	Coeficient type	exp(estimate)
Micro News	-1.16	0.01	-166.78	coefficient	0.31
Macro News	0.11	0.00	35.72	coefficient	1.11
-4/3|-1	-6.06	0.03	-174.39	scale	0.00
-1|-2/3	-3.58	0.01	-338.15	scale	0.03
-2/3|-1/3	-2.47	0.01	-371.28	scale	0.08
-1/3|0	-1.28	0.00	-281.98	scale	0.28
0|1/3	1.53	0.00	315.43	scale	4.61
1/3|2/3	2.73	0.01	374.91	scale	15.33
2/3|1	3.93	0.01	322.62	scale	50.69
1|4/3	6.68	0.05	144.51	scale	795.27

Notes: Results using ordered logit to estimate the effect of micro news and macro news on the production forecast error. The last column shows the odds ratios. Rows 3 to 10 depict the cut points of the latent variable. The full, pooled sample is used.

(b) Forecast error: set small errors to zero

	Firms' forecast errors about their production			
	(1)	(2)	(3)	(4)
Micro News	-0.117***	-0.117***		
	(0.001)	(0.001)		
Macro News	0.018***		0.018***	0.018***
	(0.0006)		(0.0006)	(0.0006)
Forecast Revision				-0.115***
				(0.001)
Observations	302,737	302,737	302,737	302,737
R^2	0.11483	0.11068	0.07974	0.11352
Within R^2	0.04244	0.03795	0.00449	0.04103

Notes: Baseline-setup except small forecast errors ($\pm\frac{1}{3}$) are set to zero. Firm-fixed effects are always included and standard errors are clustered on firm level. *** p<0.01, ** p<0.05, * p<0.1.

(c) Forecast error: set small errors to zero and and no change expected

	Firms' forecast errors about their production			
	(1)	(2)	(3)	(4)
Micro News	-0.180***	-0.180***		
	(0.001)	(0.001)		
Macro News	0.017***		0.017***	0.018***
	(0.0006)		(0.0006)	(0.0006)
Forecast Revision				-0.176***
				(0.001)
Observations	302,737	302,737	302,737	302,737
R^2	0.14873	0.14530	0.07495	0.14684
Within R^2	0.08316	0.07946	0.00369	0.08113

Notes: Baseline-setup except small forecast errors ($\pm\frac{1}{3}$) are set to zero when expectations are zero. Firm-fixed effects are always included and standard errors are clustered on firm level. *** p<0.01, ** p<0.05, * p<0.1.

Table A.2: Alternative specifications, continued.

(d) Expectations: only forecast revisions towards zero

	Firms' forecast errors about their production			
	(1)	(2)	(3)	(4)
Micro News	-0.096***	-0.100***		
	(0.003)	(0.003)		
Macro News	0.029***		0.030***	0.030***
	(0.0008)		(0.0009)	(0.0008)
Forecast Revision				-0.091***
				(0.003)
Observations	205,962	205,962	205,962	205,962
R^2	0.17471	0.16626	0.16331	0.17355
Within R^2	0.02447	0.01449	0.01100	0.02310

Notes: Baseline-setup except that we only use observations where firms revise their expectations towards zero. Firm-fixed effects are always included and standard errors are clustered on firm level.
*** p<0.01, ** p<0.05, * p<0.1.

(e) Expectations: only forecast revisions towards zero and set small errors to zero

	Firms' forecast errors about their production			
	(1)	(2)	(3)	(4)
Micro News	-0.076***	-0.078***		
	(0.002)	(0.002)		
Macro News	0.023***		0.024***	0.024***
	(0.0008)		(0.0008)	(0.0008)
rev				-0.072***
				(0.002)
Observations	205,962	205,962	205,962	205,962
R^2	0.14172	0.13519	0.13288	0.14081
Within R^2	0.01833	0.01086	0.00823	0.01729

Notes: Baseline-setup except that we only use observations where firms revise their expectations towards zero and set small forecast errors ($\pm\frac{1}{3}$) to zero. Firm-fixed effects are always included and standard errors are clustered on firm level. *** p<0.01, ** p<0.05, * p<0.1.

(f) Macro news: manufacturing orders rather than ifo index

	Firms' forecast errors about their production			
	(1)	(2)	(3)	(4)
Micro News	-0.194***	-0.194***		
	(0.001)	(0.001)		
Macro News	0.005***		0.005***	0.005***
	(0.0003)		(0.0003)	(0.0003)
Forecast Revision				-0.190***
				(0.001)
Observations	298,586	298,586	298,586	298,586
R^2	0.16100	0.16006	0.08580	0.15828
Within R^2	0.08321	0.08217	0.00103	0.08023

Notes: Baseline-setup except macro news are constructed from the median professional forecast of manufacturing orders. Firm-fixed effects are always included and standard errors are clustered on firm level.
*** p<0.01, ** p<0.05, * p<0.1.

Table A.2: Alternative specifications, continued.

(g) Macro component of forecast revision: sectoral level rather than aggregate

	Firms' forecast errors about their production				
	(1)	(2)	(3)	(4)	(5)
Micro News	-0.194***		-0.194***	-0.194***	
	(0.001)		(0.001)	(0.001)	
Macro News	0.021***	0.021***			
	(0.0007)	(0.0007)			
Micro News (Time X Sector FE absorbed)		-0.196***			-0.196***
		(0.001)			(0.001)
Δ ifo Index			0.001***		
			(0.0002)		
Average Forecast Revision				0.308***	
				(0.019)	
Average Forecast Revision by Sector					0.129***
					(0.013)
Observations	302,737	302,737	301,185	302,737	302,737
R^2	0.16471	0.16555	0.16017	0.16186	0.16169
Within R^2	0.08701	0.08793	0.08214	0.08389	0.08371

Notes: Baseline-setup except we control for sectoral news in Column 2, construct macro news as first difference of the ifo index in Column 3, construct macro news as average forecast revision in Column 4, and construct macro news as sectoral average forecast revision in Column 5. Firm-fixed effects are always included and standard errors are clustered on firm level. *** p<0.01, ** p<0.05, * p<0.1.

(h) Data type: qualitative expectations about their business situation, interpretation as changes

	Firms' forecast errors about their business situation			
	(1)	(2)	(3)	(4)
Micro News	-0.448***	-0.448***		
	(0.003)	(0.003)		
Macro News	0.697***		0.693***	0.853***
	(0.043)		(0.042)	(0.043)
Forecast Revision				-0.440***
				(0.003)
Observations	161,399	161,399	164,492	161,399
R^2	0.33211	0.32989	0.26488	0.33054
Within R^2	0.09112	0.08809	0.00298	0.08898

Notes: Baseline-setup expect we consider qualitative data for firms' own business situation rather than their production. Here, firms can report their expected and actual business situation on a scale from 0 to 100. For the exact wording of the questions see Table A.1. We treat expectations as measured in changes and realizations as measured in levels, so we take the realized change in business between t and $t+6$ and subtract from it the expectation in t to obtain the error in t. Firm-fixed effects are always included and standard errors are clustered on firm level. *** p<0.01, ** p<0.05, * p<0.1.

B SIGE Data

The Survey on Inflation and Growth Expectations (SIGE) is a quarterly business survey launched in 1999. Until 2011 it features roughly 500 firms per quarter, 1,000 firms between 2011 and 2019, and more than 1,500 since 2021. The median firm responds in 7 quarters and 20 percent of firms respond in more than 23 quarters.[16] The questions relevant to our purposes are in Table B.1. These questions elicit growth rates in percentage points. The wording of Q3 about expected inflation ensures that firms receive the most recent inflation rates in Italy and the euro area.

Table B.1: Relevant questions from SIGE

Label	Name	Introduced	Wording
Q1	realized change in own prices	2002q4	In the last 12 months, what has been the average change in your firm's prices?
Q2	expected change in own price	1994q4	For the next 12 months, what do you expect will be the average change in your firm's prices?
Q3	expected inflation (12 months ahead)	1994q4	In July consumer price inflation, measured by the 12-month change in the harmonized index of consumer prices was 8.4 per cent in Italy and 8.9 per cent in the euro area. What do you think it will be in Italy in September 2023?
Q4	expected inflation (6 months ahead)	2010q4	In July consumer price inflation, measured by the 12-month change in the harmonized index of consumer prices was 8.4 per cent in Italy and 8.9 per cent in the euro area. What do you think it will be in Italy in March 2023?

Notes: Wording taken from the September 2022 edition. Starting in 2012q3 alternative wordings for expected inflation (Q3) was used for subsets of firms. We focus on the traditional wording including information about recent inflation. This wording is shown to 60 percent of the sample.

To construct expectation errors and news, we follow our earlier strategy for the ifo survey as closely as possible. For expectation errors over a given twelve months period, we subtract from the ex-post realized change (Q1 in Table B.1) the ex-ante expected change (Q2). In line with the convention for the ifo survey in (1), we assign this error to the quarter in which the expectation was elicited. For micro news, we directly follow the definition in the ifo survey and use the first difference of expected price changes (Q2) net of a time-fixed effect as in (3). For macro news and to the best of our knowledge, there is no indicator in Italy that could play the role of the German ifo indicator. However, we can construct alternative measures for macro news. In our baseline specification, we consider the first difference in inflation expectations as macro news that are specific to each firm. Hence, in this specification, both micro and macro news are based on first differences of forecast revisions.

[16]For more details on the SIGE, see Grasso and Ropele (2018) and Coibion et al. (2020).

C Model solution

Below, we provide the proofs for the proposition in Section 4. In a preliminary step, we outline the model solution and key equilibrium relationships. Throughout, we consider a linear approximation to the equilibrium conditions of the model. Lower-case letters indicate percentage deviations from steady state. We solve the model by backward induction. That is, we start by deriving inflation expectations regarding period $t+1$. Using the result in the Euler equation of the third stage of period t allows us to determine price-setting decisions during stage two. Eventually, we obtain the short-run responses of aggregate variables to unexpected changes in productivity or optimism shocks.

Expectations regarding period $t+1$. Below, $E_{k,t}$ stands for either $E_{j,l,t}$, referring to the information set of producer j on island l at the time of her pricing decision, or for $E_{l,t}$, referring to the information set of the household on island l at the time of its consumption decision. Variables with only time subscripts refer to economy-wide values. The wage in period $t+1$ is set according to the expected aggregate labor supply

$$E_{k,t}\varphi l_{t+1} = E_{k,t}(w_{t+1} - p_{t+1} - c_{t+1}).$$

This equation is combined with the aggregated production function

$$E_{k,t}y_{t+1} = E_{k,t}(x_{t+1} + \alpha l_{t+1}),$$

the expected aggregate labor demand

$$E_{k,t}(w_{t+1} - p_{t+1}) = E_{k,t}[x_{t+1} + (\alpha - 1)l_{t+1}],$$

and market clearing $y_{t+1} = c_{t+1}$ to obtain

$$E_{k,t}x_{t+1} = E_{k,t}y_{t+1} = E_{k,t}c_{t+1}. \tag{A-1}$$

Furthermore, the expected Euler equation, together with the Taylor rule, is

$$E_{k,t}c_{t+1} = E_{k,t}(c_{t+2} + \pi_{t+2} - \psi\pi_{t+1}).$$

Agents expect the economy to be in a new steady state tomorrow ($E_{k,t}c_{t+1} = E_{k,t}c_{t+2}$), given the absence of state variables other than technology, which follows a unit root process, and the demand shock, whose expected value is zero. Ruling out explosive paths yields

$$E_{k,t}\pi_{t+2} = E_{k,t}\pi_{t+1} = 0.$$

Stage three of period *t*. After prices are set, each household observes n prices in the economy. Since only productivity is idiosyncratic to firms at the time of setting prices, the productivity level $a_{j,l,t} = a_{l,t}$—which is the same for all producers $j \in [0,1]$ on island l—can be inferred from each price $p_{j,l,t}$ of the good from producer j on island l. Hence, household l forms its expectations about the change in aggregate productivity according to

$$E_{l,t}\Delta x_t = \delta_x^h \hat{a}_{l,t},$$

where $\hat{a}_{l,t}$ is the average over the realizations of $a_{m,t} - x_{t-1}$ for each location m in household l's sample $\mathcal{B}_{l,1}$. The coefficients δ_x^h is equal across households and depend on n, σ_ε^2, and σ_η^2 in the following way:

$$\delta_x^h = \underbrace{\frac{\sigma_\varepsilon^2}{\sigma_\varepsilon^2 + \sigma_\eta^2/n}}_{\to 1 \text{ if } n \to \infty}. \tag{A-2}$$

Furthermore, households rationally incorporate the information contained in the public signal concerning the aggregate demand shock into their expectations of the aggregate price level.

The expectation formation of producers is discussed in the main text. Consumption follows an Euler equation with household-specific inflation, as only a subset of goods is bought. Agents expect no differences between households for $t+1$, such that expected aggregate productivity and the overall price level impact today's individual consumption. Additionally using $E_{l,t}p_{t+1} = E_{l,t}p_t$ and $E_{l,t}x_{t+1} = E_{l,t}x_t$ gives

$$c_{l,t} = E_{l,t}x_t + E_{l,t}p_t - p_{l,t} - r_t + q_{l,t}. \tag{A-3}$$

Similar to the updating formula for technology estimates, households all relevant available information to form an estimate about the aggregate price level p_t according to

$$E_{l,t}p_t = \delta_p^h \hat{a}_{l,t} + \kappa_p^h w_t + \tau_p^h x_{t-1} - \eta_p^h r_t + \bar{\rho}_p^h s_t + \bar{\delta}_p^h q_{l,t}, \tag{A-4}$$

where the undetermined coefficients $\delta_p^h, \kappa_p^h, \tau_p^h, \eta_p^h, \bar{\rho}_p^h$, and $\bar{\delta}_p^h$ represent the impact of the relevant variable on the expected price level. Combining the above gives

$$c_{l,t} = (1+\tau_p^h)x_{t-1} + \delta_{xp}^h \hat{a}_{l,t} + \kappa_p^h w_t - (1+\eta_p^h)r_t - p_{l,t} + \bar{\rho}_p^h s_t + (1+\bar{\delta}_p^h)q_{l,t} \tag{A-5}$$

where $\delta_{xp}^h = \delta_x^h + \delta_p^h$. We will solve for the coefficients below. Total demand for good j on island l is

$$\begin{aligned} y_{j,l,t} &= -\gamma p_{j,l,t} + \gamma \sum_{m \in \mathcal{B}_{l,t}} \frac{p_{m,t}}{n} + \sum_{m \in \mathcal{B}_{l,t}} \frac{c_{m,t}}{n} \\ &= -\gamma p_{j,l,t} + \gamma \tilde{p}_{l,t} + \tilde{y}_{l,t}, \end{aligned} \tag{A-6}$$

where $\tilde{y}_{l,t}$ is the average consumption level of customers visiting island l, $1/n$th of which equals $p_{j,l,t}$. The index $\tilde{p}_{l,t}$ is the average price index of customers visiting island l. If customers bought on all (that is, infinitely many) islands in the economy, $\tilde{p}_{l,t}$ would correspond to the overall price level. Given (A-5), we have, with $\kappa^h = (1+\tau_p^h)x_{t-1} - (1+\eta_p^h)r_t + \kappa_p^h w_t$,

$$\begin{aligned} \tilde{y}_{l,t} &= \frac{1}{n} \sum_{m \in \mathcal{B}_{l,t}} \left[E_{m,t} x_t + E_{m,t} p_t - p_{m,t} - r_t + q_{m,t} \right] \\ &= \kappa^h + \delta_{xp}^h \sum_{m \in \mathcal{B}_{l,t}} \frac{\hat{a}_{m,t}}{n} - \sum_{m \in \mathcal{B}_{l,t}} \frac{p_{m,t}}{n} + (1+\bar{\delta}_p^h) \left(q_t + \sum_{m \in \mathcal{B}_{l,t}} \frac{\bar{q}_{m,t}}{n} \right) + \bar{\rho}_p^h s_t. \end{aligned} \tag{A-7}$$

Stage two of period t. During the second stage, firms obtain idiosyncratic signals about their productivity. Firms set prices according to

$$\begin{aligned} p_{j,l,t} &= w_t + \frac{1-\alpha}{\alpha} E_{j,l,t} y_{j,l,t} - \frac{1}{\alpha} a_{l,t} \\ &\equiv k' + k_1' E_{j,l,t} \tilde{p}_{l,t} + k_2' E_{j,l,t} \tilde{y}_{l,t} - k_3' a_{l,t}, \end{aligned}$$

with

$$k' = \frac{\alpha}{\alpha + \gamma(1-\alpha)} w_t \qquad k_1' = \frac{\gamma(1-\alpha)}{\alpha + \gamma(1-\alpha)} \qquad k_2' = \frac{1-\alpha}{\alpha + \gamma(1-\alpha)} \qquad k_3' = \frac{1}{\alpha + \gamma(1-\alpha)}. \tag{A-8}$$

From here onwards, expressions that are based on common knowledge only (such as k') are treated like parameters in notation terms, i.e., they lack a time index. This facilitates the important distinction between expressions that are common information and those that are not. Evaluating the expectation of firm j about island-specific demand in period t, using

(A-7), results in

$$E_{j,l,t}\tilde{y}_{l,t} = \kappa^h + \delta^h_{xp}\left(\frac{1}{n}(a_{l,t} - x_{t-1}) + \frac{n-1}{n}E_{j,l,t}\varepsilon_t\right) - \left(\frac{1}{n}p_{j,l,t} + \frac{n-1}{n}E_{j,l,t}p_t\right) + \left[(1+\bar{\delta}^h_p)\rho^p_q + \bar{\rho}^h_p\right]s_t. \tag{A-9}$$

where ρ^p_q is the coefficient used by producers to form expectations about the aggregate demand shock based on the signal, and κ^h contains only publicly available information. Furthermore, it is taken into account that the productivity and prices of island l have a non-zero weight in the sample of productivity and price levels observed by consumers visiting island l. Note that producers still take the price index of the consumers as given, since they buy infinitely many goods on the same island.

Inserting the firm expectation (A-9) into the pricing equation (A-8) yields (here, p_t is the average of the prices charged by producers of all other islands, which is the overall price index)

$$p_{j,l,t} \equiv k + k_1 E_{j,l,t}p_t - k_3 a_{l,t} + k_4 s_t,$$

with

$$\Xi = 1 - \frac{1}{n}(k'_1 - k'_2) \qquad k = \frac{1}{\Xi}\left\{k' + k'_2\kappa^h + \frac{k'_2\delta^h_{xp}}{n}\left[(n-1)(1-\delta^p_x) - 1\right]x_{t-1}\right\}$$
$$k_1 = \frac{n-1}{n\Xi}(k'_1 - k'_2) \qquad k_3 = \frac{1}{\Xi}\left\{k'_3 - \frac{k'_2\delta^h_{xp}}{n}\left[(n-1)\delta^p_x + 1\right]\right\} \qquad k_4 = \frac{k'_2}{\Xi}\left[(1+\bar{\delta}^h_p)\rho^p_q + \bar{\rho}^h_p\right]. \tag{A-10}$$

Note that, according to (A-8), $0 < k'_1 - k'_2 < 1$ because $0 < \alpha < 1$ and $\gamma > 1$. Using the definition of k_1 in (A-10), this implies (observe that $n > 1$)

$$0 < k_1 < 1.$$

Aggregating over all producers gives the aggregate price index

$$p_t = k + k_1\overline{E}_t p_t - k_3 x_t + k_4 s_t,$$

where $\int a_{l,t}dl = x_t$, and $\overline{E}_t p_t = \iint E_{j,l,t}p_t\, djdl$ is the average expectation of the price level.

The expectation of firm j of this aggregate is therefore

$$\begin{aligned} E_{j,l,t}p_t &= k - k_3 E_{j,l,t}x_t + k_1 E_{j,l,t}\overline{E}_t p_t + k_4 s_t \\ &= k - k_3\delta^p_x a_{l,t} - k_3(1-\delta^p_x)x_{t-1} + k_1 E_{j,l,t}\overline{E}_t p_t + k_4 s_t. \end{aligned} \tag{A-11}$$

Inserting the last equation into (A-10) gives

$$p_{j,l,t} = k + k_1 k - k_1 k_3 (1-\delta_x^p) x_{t-1} - (k_3 + k_1 k_3 \delta_x^p)\, a_{l,t} + k_1^2 E_{j,l,t} \overline{E}_t p_t + (k_4 + k_1 k_4) s_t.$$

To find $E_{j,l,t}\overline{E}_t p_t$, note that firm j's expectations of the average of (A-11) are

$$E_{j,l,t}\overline{E}_t p_t = k - k_3(1-\delta_x^p)(1+\delta_x^p) x_{t-1} - k_3 \delta_x^{p2} a_{l,t} + k_1 E_{j,l,t} \overline{E}_t^{(2)} p_t + k_4 s_t.$$

where $\overline{E}^{(2)}$ is the average expectation of the average expectation. The price of firm j is found by plugging the last equation into the second-to-last:

$$\begin{aligned} p_{j,l,t} =& k + k_1 k + k_1^2 k - \Big[k_1 k_3 (1-\delta_x^p) + k_1^2 k_3 (1-\delta_x^p)(1+\delta_x^p)\Big]\, x_{t-1} \\ &- \Big[k_3(1+k_1\delta_x^p) + k_1^2 k_3 \delta_x^{p2}\Big]\, a_{l,t} + [k_4 + k_1 k_4 + k_1^2 k_4] s_t + k_1^3 E_{j,l,t} \overline{E}^{(2)} p_t. \end{aligned}$$

Continuing like this results in some infinite sums

$$\begin{aligned} p_{j,l,t} =& k\Big(1 + k_1 + k_1^2 + k_1^3 \ldots\Big) \\ &- k_1 k_3 (1-\delta_x^p)\Big[1 + k_1(1+\delta_x^p) + k_1^2(1+\delta_x^p+\delta_x^{p2}) + k_1^3(1+\delta_x^p+\delta_x^{p2}+\delta_x^{p3}\ldots)\Big] x_{t-1} \\ &- k_3\Big(1 + k_1\delta_x^p + k_1^2\delta_x^{p2} + k_1^3\delta_x^{p3}\ldots\Big)\, a_{l,t} + \Big[k_4 + k_1 k_4 + k_1^2 k_4 + k_1^3 k_4 + \ldots\Big] s_t \\ &+ k_1^\infty E_{j,l,t}\overline{E}^{(\infty)} p_t. \end{aligned}$$

This results in

$$p_{j,l,t} = \frac{k}{1-k_1} - \frac{k_1(1-\delta_x^p)}{1-k_1}\frac{k_3}{1-k_1\delta_x^p} x_{t-1} - \frac{k_3}{1-k_1\delta_x^p} a_{l,t} + \frac{1}{1-k_1} k_4 s_t + \underbrace{k_1^\infty \overline{E}_t^{(\infty)}}_{\to 0} p_t$$

or

$$p_{j,l,t} = \bar{k}_1 + \bar{k}_3 a_{l,t} + \bar{k}_4 s_t. \tag{A-12}$$

with

$$\bar{k}_1 = \frac{1}{1-k_1}\left[k - (1-\delta_x^p)\frac{k_1 k_3}{1-k_1\delta_x^p} x_{t-1}\right] \qquad \bar{k}_3 = -\frac{k_3}{1-k_1\delta_x^p} \qquad \bar{k}_4 = \frac{1}{1-k_1} k_4.$$

The average over all producers yields the aggregate price index as

$$p_t \equiv \bar{k}_1 + \bar{k}_3 x_t + \bar{k}_4 s_t. \tag{A-13}$$

To arrive at qualitative predictions for the impact of the structural shocks ε_t and q_t on output growth and the forecast error, we need to determine the sign and the size of $\bar{k}_3$. Note that, according to (A-10),

$$-k_3 = \delta^h_{xp} \frac{k'_2 - nk'_3/\delta^h_{xp} + k'_2(n-1)\delta^p_x}{n - (k'_1 - k'_2)},$$

where the first part of the numerator can be rewritten, by observing (A-8), as

$$k'_2 - nk'_3/\delta^h_{xp} = \frac{1 - n/\delta^h_{xp} - \alpha}{\alpha + \gamma(1-\alpha)}.$$

Using (A-8) and (A-10) thus yields

$$-k_3 = \delta^h_{xp} \frac{(1-\alpha)[(n-1)\delta^p_x + 1] - n/\delta^h_{xp}}{(n-1)[\alpha + \gamma(1-\alpha)] + 1}.$$

Plugging this into the definition of $\overline{k}_3$ in (A-13) gives

$$\overline{k}_3 = \delta^h_{xp} \frac{\frac{(1-\alpha)[(n-1)\delta^p_x + 1] - n/\delta^h_{xp}}{(n-1)[\alpha+\gamma(1-\alpha)]+1}}{1 - \delta^p_x \frac{(n-1)(\gamma-1)(1-\alpha)}{(n-1)[\alpha+\gamma(1-\alpha)]+1}}.$$

To obtain $\delta^h_{xp} = \delta^h_x + \delta^h_p$, we need to find the undetermined coefficients of equation (A-4). Start by comparing this equation with household l's expectation of equation (A-13):

$$E_{l,t}p_t = \underbrace{\overline{k}_1 + \overline{k}_3 x_{t-1}}_{\kappa^h_p w_t + \tau^h_p x_{t-1} - \eta^h_p r_t} + \underbrace{\overline{k}_3 \delta^h_x}_{\delta^h_p} \hat{a}_{l,t} + \underbrace{\bar{k}_4}_{\bar{\rho}^h_p} s_t, \tag{A-14}$$

with $\bar{\delta}^h_p = 0$, since the household knows that price-setters only have the public signal regarding demand, but not any information about actual demand. Hence, $\delta^h_{xp} = \delta^h_x(1 + \overline{k}_3)$. Inserting this into the above expression for $\overline{k}_3$ yields

$$\overline{k}_3 \equiv -\frac{n/\Sigma - \delta^h_x \Psi}{\Phi - \delta^h_x \Psi}, \tag{A-15}$$

with

$$\Sigma = (n-1)[\alpha + \gamma(1-\alpha)] + 1 > 0 \qquad \Psi = (1-\alpha)[(n-1)\delta^p_x + 1]/\Sigma > 0$$
$$\Phi = 1 - \delta^p_x(n-1)(\gamma-1)(1-\alpha)/\Sigma.$$

The signs obtain because $n > 1, 0 < \alpha < 1, \delta^p_x > 0$, and $\gamma > 1$. Observe that $\Psi\Sigma < n$ because

$\delta_x^p \leq 1$. Hence, $n/\Sigma - \delta_x^h \Psi > 0$ because

$$n - \underbrace{\delta_x^h}_{>0,<1} \underbrace{\Psi\Sigma}_{<n} > 0,$$

implying that the numerator of (A-15) is positive. Turning to the denominator $\Phi - \delta_x^h \Psi$, note that $\Phi - \Psi > 0$. The denominator of (A-15) is therefore positive as well, and we have $\bar{k}_3 < 0$. Next, consider that $n/\Sigma < \Phi$ and we obtain

$$-1 < \bar{k}_3 < 0.$$

This is a key result for the derivation of the proposition in Appendix D.

We now turn to $\bar{k}_4$. First observe that

$$\begin{aligned}\Xi &= 1 - \frac{1}{n}(k_1' - k_2') \\ &= \frac{[(n-1)\gamma + 1](1-\alpha) + n\alpha}{n[\alpha + \gamma(1-\alpha)]} > 0\end{aligned}$$

and

$$k_1 = \frac{(n-1)\varepsilon(1-\alpha) + (n-1)\alpha + 1 - n}{(n-1)\varepsilon(1-\alpha) + (n-1)\alpha + 1} < 1.$$

Thus,

$$\begin{aligned}\bar{k}_4 &= \frac{1}{1-k_1} \frac{k_2'}{\Xi} \left[\bar{k}_4 + \rho_q^p\right] \\ &= \frac{k_2'}{(1-k_1)\Xi - k_2'} \rho_q^p.\end{aligned}$$

Since $k_2' > 0$, for $\bar{k}_4 > 0$, we need to show that

$$(1 - k_1)\Xi > k_2'$$

or

$$n\alpha^2 > -\alpha(1-\alpha)[(n-1)\gamma + 1],$$

which is true, such that $\bar{k}_4 > 0$.

Stage one of period t As information sets of agents are perfectly aligned during stage one, we use the expectation operator E_t to denote (common) stage-one expectations in what follows. Combining the results regarding expectations about inflation in period $t+1$ with the Euler equation, the Taylor rule, and the random-walk assumption for x_t gives, see equation (A-3),

$$E_t c_t = E_t y_t = E_t x_t + (1-\psi)E_t \pi_t + E_t q_t.$$

Remember that the monetary policy shock emerges after wages are set. Its expected value before wage-setting is zero, just like the expected value of the demand shock, as the signal is not yet released. Labor supply is given by

$$\varphi E_t l_t = E_t(w_t - p_t - c_t + q_t).$$

This equation can be combined with the aggregated production function

$$E_t y_t = E_t(x_t + \alpha l_t),$$

the expected aggregate labor demand

$$E_t(w_t - p_t) = E_t[x_t + (\alpha - 1)l_t],$$

and market clearing $y_t = c_t$ to obtain

$$\varphi E_t l_t = E_t(x_t + (\alpha - 1)l_t - c_t] + q_t$$

or

$$E_t y_t = E_t x_t.$$

Comparing this expression to the Euler equation, we get

$$E_t \pi_t = 0.$$

Nominal wages are set in line with these expectations. We thus have determinacy of the price level. The central bank then sets its interest rate based on expected inflation.

D Proofs

Proof of Proposition 1 Calculating the expectation error of firms for idiosyncratic output, using demand equation (A-6), the island-specific demand (A-7), and the price-level equation (A-13), yields

$$
\begin{aligned}
FE_{j,l,t} &= \Delta y_{j,l,t} - E_{j,l,t}\Delta y_{j,l,t} = \gamma \frac{n-1}{n}\left(p_t - E_{j,l,t}p_t\right) + \tilde{y}_{l,t} - E_{j,l,t}\tilde{y}_{l,t} \\
&= \frac{n-1}{n}\left[(\gamma-1)\bar{k}_3 + \delta_x^h(1+\bar{k}_3)\right]\left(\varepsilon_t - E_{j,l,t}\varepsilon_t\right) + q_t - E_{j,l,t}q_t + \sum_{m\in\mathcal{B}_{l,t}} \frac{\bar{q}_{k,t}}{n} \\
&\equiv \Lambda\left(\varepsilon_t - E_{j,l,t}\varepsilon_t\right) + q_t - E_{j,l,t}q_t + \sum_{m\in\mathcal{B}_{l,t}} \frac{\bar{q}_{k,t}}{n},
\end{aligned}
\tag{A-16}
$$

where the Euler equations (A-5) of customers of island l is used in the second equation. The effect Λ of the expectation error regarding aggregate technology innovations $\varepsilon_t - E_{j,l,t}\varepsilon_t$ on the expectation error regarding own output is negative if

$$
\gamma - 1 > -\delta_x^h \frac{1+\bar{k}_3}{\bar{k}_3}. \tag{A-17}
$$

Since

$$
-\frac{1+\bar{k}_3}{\bar{k}_3} = \frac{(n-1)(1-\alpha)(\gamma-1)(1-\delta_x^p)}{n - \delta_x^h(1-\alpha)[(n-1)\delta_x^p + 1]},
$$

inequality (A-17) is fulfilled if

$$
1 > \delta_x^h(1-\alpha),
$$

which is correct, such that $\Lambda < 0$. The gap between expected own and aggregate output can be calculated using (A-6), (A-9), (A-12), and (A-13):

$$
\begin{aligned}
E_{j,l,t}y_{j,l,t} - E_{j,l,t}y_t &= -\gamma\frac{n-1}{n}\left(p_{j,l,t} - E_{j,l,t}p_t\right) + E_{j,l,t}\tilde{y}_{l,t} - E_{j,l,t}y_t \\
&= \frac{1}{n}\left[-\gamma(n-1)\bar{k}_3 + \delta_x^h(1+\bar{k}_3) - \bar{k}_3\right] E_{j,l,t}\eta_{l,t} \equiv K_1 E_{j,l,t}\eta_{l,t}.
\end{aligned}
\tag{A-18}
$$

Aggregating individual Euler equations (A-3) over all individuals, using (A-13), and (A-14) gives aggregate output as

$$
y_t = E_{l,t}x_t + E_{l,t}p_t - p_t - r_t + q_t = x_{t-1} + \underbrace{\left[\delta_x^h - \bar{k}_3(1-\delta_x^h)\right]}_{>0}\varepsilon_t + q_t \underbrace{-\frac{\alpha}{\alpha + \psi(1-\alpha)}}_{<0}\nu_t.
$$

Note that, if households have full information ($n \to \infty$), we get $\delta_x^h \to 1$ and $y_t = x_t - \nu_t \alpha/(\alpha + \psi(1-\alpha))$. The signs indicated above result from $0 < -\overline{k}_3 < 1$ (derived above).

Forecast revisions are then given by the change in expectations between before and after receiving the private and public signals (that is, between stage one and stage two). The last equation implies

$$E_{j,l,t} y_t - x_{t-1} = \left[\delta_x^h - \overline{k}_3(1-\delta_x^h)\right] E_{j,l,t}\varepsilon_t + \rho_q^p s_t - \frac{\alpha}{\alpha + \psi(1-\alpha)}\nu_t.$$

Using this equation together with equation (A-18) in the forecast revision gives

$$\begin{aligned} FR_{j,l,t} &= E_{j,l,t}(y_{j,l,t} - y_{j,l,t-1}) - E_t(y_{j,l,t} - y_{j,l,t-1}) = E_{j,l,t} y_{j,l,t} - E_{j,l,t} y_t + E_{j,l,t} y_t - E_t y_t \\ &= K_1 E_{j,l,t}\eta_{l,t} + \left[\delta_x^h - \overline{k}_3(1-\delta_x^h)\right] E_{j,l,t}\varepsilon_t + \rho_q^p s_t - \frac{\alpha}{\alpha + \psi(1-\alpha)}\nu_t. \end{aligned}$$

Since

$$E_{j,l,t}\varepsilon_{l,t} = \delta_x^p(\varepsilon_t + \eta_{l,t}) \qquad E_{j,l,t}\eta_{l,t} = (1-\delta_x^p)(\varepsilon_t + \eta_{l,t}) \tag{A-19}$$

we can write the above as

$$\begin{aligned} FR_{j,l,t} &= K_1(1-\delta_x^p)(\varepsilon_t + \eta_{l,t}) + \left[\delta_x^h - \overline{k}_3(1-\delta_x^h)\right]\delta_x^p(\varepsilon_t + \eta_{l,t}) + \rho_q^p s_t - \frac{\alpha}{\alpha + \psi(1-\alpha)}\nu_t \\ &\equiv X_1\varepsilon_t + X_1\eta_{l,t} + X_1^q q_t + X_1^q e_t + K_\nu \nu_t. \end{aligned}$$

with

$$X_1 = K_1(1-\delta_x^p) + \left[\delta_x^h - \overline{k}_3(1-\delta_x^h)\right]\delta_x^p \qquad X_1^q = \rho_q^p \qquad K_\nu = -\frac{\alpha}{\alpha + \psi(1-\alpha)}.$$

Similarly, making use of (A-19), the forecast error (A-16) can be written as

$$FE_{j,l,t} = \Lambda\left[(1-\delta_x^p)\varepsilon_t - \delta_x^p\eta_{l,t}\right] + (1-\rho_q^p)q_t - \rho_q^p e_t + \sum_{m\in\mathcal{B}_{l,t}} \frac{\bar{q}_{k,t}}{n}.$$

The sign of β of regression (10) can then be determined in two steps. Since both independent variables, forecast revisions and the signal, are correlated, we first regress forecast revisions on the signal, yielding the regression coefficient

$$Coef_1 = \frac{Cov(FR_{j,l,t}, s_t)}{Var(s_t)} = \frac{X_1^q\sigma_q^2 + X_1^q\sigma_e^2}{\sigma_q^2 + \sigma_e^2} = X_1^q.$$

The residual of this regression can therefore be written as $FR_{j,l,t} - Coef_1 s_t$. The sign of the coefficient β of regression (10) then depends on the sign of

$$\begin{aligned}
Cov(FE_{j,l,t}; FR_{j,l,t} - Coef_1 s_t) &= Cov(FE_{j,l,t}; FR_{j,l,t}) - Coef_1 Cov(FE_{j,l,t}, s_t) \\
&= \underbrace{(X_1^q - Coef_1)}_{=0} R_e^q + \underbrace{\Lambda X_1}_{<0} \underbrace{R_\eta}_{>0} < 0,
\end{aligned}$$

with

$$R_e^q = (1-\rho_q^p)\sigma_q^2 - \rho_q^p \sigma_{e,q}^2 \qquad R_\eta = (1-\delta_x^p)\sigma_\varepsilon^2 - \delta_x^p \sigma_\eta^2.$$

The signs obtain from $\Lambda < 0$ and

$$K_1 = \frac{1}{n}\left[-\gamma(n-1)\bar{k}_3 + \delta_x^h(1+\bar{k}_3) - \bar{k}_3\right] > 0 \qquad X_1 = K_1(1-\delta_x^p) + \left[\delta_x^h - \bar{k}_3(1-\delta_x^h)\right]\delta_x^p > 0,$$

as well as

$$R_\eta > 0 \quad \text{if} \quad \frac{\hat{\sigma}_\eta^2}{\hat{\sigma}_\varepsilon^2} > \frac{\sigma_\eta^2}{\sigma_\varepsilon^2},$$

that is

$$R_\eta > 0 \quad \text{if} \quad \frac{1-\Upsilon\varpi}{\Upsilon\varpi} > \frac{1-\varpi}{\varpi},$$

which results from the assumption of island illusion, $\Upsilon < 1$. Hence, $\beta < 0$.

The sign of the coefficient δ of regression (10) can equivalently derived by first regressing the forecast revision on the signal, which gives the coefficient

$$Coef_2 = \frac{Cov(FR_{j,l,t}, s_t)}{Var(FR_{j,l,t})} = \frac{X_1^q \sigma_q^2 + X_1^q \sigma_e^2}{X_1^2\sigma_\varepsilon^2 + X_1^2\sigma_\eta^2 + (X_1^q)^2\sigma_q^2 + (X_1^q)^2\sigma_e^2 + (K_\nu)^2\sigma_\nu^2},$$

which is positive since $X_1^q > 0$. The sign of δ in regression (10) then depends on the sign of

$$\begin{aligned}
Cov(FE_{j,l,t}; s_t - Coef_2(FR_{j,l,t})) &= Cov(FE_{j,l,t}; s_t^q) - Coef_2 Cov(FE_{j,l,t}, FR_{j,l,t}) \\
&= \underbrace{(1 - Coef_2 X_1^q)}_{>0} \underbrace{R_e^q}_{>0} \underbrace{-Coef_2}_{<0} \underbrace{\Lambda X_1}_{<0} R_\eta.
\end{aligned}$$

The signs obtain because

$$1 - Coef_2 X_1^q = \frac{X_1^2\sigma_\varepsilon^2 + X_1^2\sigma_\eta^2 + (K_\nu)^2\sigma_\nu^2}{X_1^2\sigma_\varepsilon^2 + X_1^2\sigma_\eta^2 + (X_1^q)^2\sigma_q^2 + (X_1^q)^2\sigma_e^2 + (K_\nu)^2\sigma_\nu^2},$$

which is positive but smaller than unity, and

$$R_e^q > 0 \quad \text{if} \quad \frac{\hat{\sigma}_e^2}{\hat{\sigma}_q^2} > \frac{\sigma_e^2}{\sigma_q^2},$$

which results from the assumption of island illusion. Hence, $\delta > 0$. ■

The proofs for propositions 2 and 3 are available on www.uni-hd.de/zenoenders.